JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES
VOL. 26 OCTOBER 15, 1936 NO. 10

PALEONTOLOGY.—*A new species of* "Crassatellites" *from the upper Miocene of Florida.*[1] W. C. MANSFIELD, U. S. Geological Survey.

"Crassatellites" (Hybolophus?) leonensis Mansfield

Crassatellites (*Crassatellites*) *gibbesii* Mansfield, Florida State Geol. Survey. Bull. 8, pp. 80, 81, pl. 16, fig. 9, 1932. (Not *"Crassatellites" gibbesii* Tuomey and Holmes, 1856.)

In the above publication, I identified specimens from the *Ecphora* zone and the *Cancellaria* zone (upper Miocene) of Florida as *Crassatellites gibbesii* (Tuomey and Holmes), a species described from the Waccamaw formation of South Carolina, but stated therewith that the Florida Miocene form was more elongate than the specimens figured by Tuomey and Holmes under their species, *C. gibbesii*. After collecting more specimens of *C. gibbesii* from the Waccamaw formation and the Caloosahatchee marl, I now believe that the upper Miocene form should not be specifically united with the Pliocene form and here refer the Miocene form to a new species *"Crassatellites" leonensis*.

The adult shell of *C. leonensis* differs from *C. gibbesii* in having a much more elongate shell and coarser undulations over the beak. The concentric sculpture on the body of the Miocene shell is also more closely spaced than on the Pliocene shell. The Miocene species probably is a precursor of the Pliocene species.

Dimensions of the holotype (U.S.N.M. 371160).—Length 68 mm, height 47 mm.

Type locality.—Borrow pit, Jackson Bluff, Leon County, Fla.

Outside occurrence.—Two immature specimens collected at Raysors Bridge, Colleton County, S. C., probably belong to the new species here described. The new species probably does not occur at the Natural Well (Duplin marl) of North Carolina—the species *C. undulatus* Say occurring here; nor at Wilmington, N. C., the Pliocene species, *C. gibbesii* occurring here. *"Crassatellites" densus* Dall, a species described from the Oak Grove sand of Florida, has a more prominent posterior dorsal ridge and a smoother area over the middle of the shell than the new species here described.

[1] Published by permission of the Director, U. S. Geological Survey, Washington, D. C. Received June 11, 1936.

BOTANY.—*New species of* Arundinaria *from Southwestern China.*[1]

Y. L. KENG, Academia Sinica, National Research Institute of Biology, Nanking, China. (Communicated by Agnes Chase.)

Arundinaria violascens Keng, sp. nov.

Culmus teres, internodio primo in specimine circ. 14 cm longo, 4.5 mm crasso, dense fasciculato-ramosus, ramulis fere omnibus racemos terminales gerentibus; vaginae ad ramulum ultimum 4–6, glabrae vel saepe puberulae, pleraeque setis fuscis fimbriatae; ligula 0.3–1 mm longa, truncata; laminae 2.5–5 cm longae, 3–5 mm latae, pleraeque involutae, tessellatae, basi in petiolum brevissimum attenuatae, margine utroque scaberulae; racemus basi inclusus, 4–7 cm longus, 3–7-spiculatus, pedicellis erectis, laevibus, 4–14 mm longis; spiculae 5–9-florae, 2.7–4 cm longae, fusco-purpureae; glumae acuminatae, superne puberulae vel interdum glabrae, prima 5–7 mm longa, 3–5 nerva, secunda 7–11 mm longa, 7–9-nerva; lemmata oblongo-lanceolata, acuminata vel in acumen producta, omnino puberulo-scaberula, 9-nervia, venulis transversis reticulata, infimo 12–15 mm longo, callo pilis circ. 1 mm longis dense barbato; palea 9–10 mm longa, bidentata, puberula, ad carinas versus apicem rigide ciliata; lodiculae 3, hyalinae, ovatae, 2–2.5 mm longae, fimbriatae, inferne nervosae; antherae 3, 5–6 mm longae, flavidae; ovarium fusiforme, circ. 2 mm longum, apice in stylos 3 brevissimos divisum, stigmatibus plumosis, circ. 3 mm longis; rhachillae articuli 4 mm longi, versus apicem incrassati pubescensque.

Type in the Herbarium of the U. S. National Herbarium, no. 1214328, collected on mountains south of Likiang, near Hochin and Chiuho, Yunnan Province, May 25–28, 1922, by J. F. Rock (no. 4082).

This species is probably related to *A. Forrestii* Keng (Yunnan: Forrest 14127 in Herb. Kew), from which it differs, however, in having smaller florets, shorter anthers, and shorter but stouter rachilla-joints.

Arundinaria parvifolia Hack., sp. nov.

Culmus (cujus pars superior floriferus tantum adest) teres, tenuissimus, internodiis in specimine 25–33 mm longis, circ. 0.75 mm crassis, ramis solitariis, simplicibus, 8–15 cm longis, racemos terminales gerentibus; vaginae ad ramum floriferum 6–9, imbricatae, 1–2 cm longae, glabrae; ligula 0.3–0.5 mm longa, truncata; laminae (in vagina suprema) circ. 18 mm longae, 3 mm latae, nervo secundario utrinque 1, reticulato-venulosae, tenuiter acuminatae, basi breve angustae, margine altero scaberulae, altero cartilagineo-laeves; racemi basi inclusi, 4–5 cm longi, 5–7-spiculati, pedicellis erectis, laevibus, 1–5 mm longis, infimo spatha circ. 1 cm longa subtento; spiculae 4–6-florae, 15–25 mm longae, viridulae; glumae acuminatae vel in acumen productae, tenues, stramineae, 3–5-nerves, prima 5–6 mm, secunda 6–7 mm longa; lemmata oblongo-lanceolata, acuminata, 7–nervia, trabeculosa, praeter callum pubescens glabra, primo 8–9 mm longo; palea bidentata, lemma aequans vel paulo superans, praeter carinas saepe 6-nervis, laevis vel ad carinas versus apicem scaberula; lodiculae 3, ovatae, 2.5 mm longae, superne ciliatae; antherae 3, 5 mm longae, pallidae; stigmata 2, circ. 2 mm longa, tenuissime plumosa; rhachillae articuli tenues, glabri, 3–4 mm longi.

[1] Received May 27, 1936.

Type in the U. S. National Herbarium, no. 1126301, collected in Yunnan Province but without precise locality, 1910, by E. E. Maire (no. 7532).

This species is characterized by the glabrous rachilla-joints and the palea equaling or exceeding the lemma. Described from a single specimen ex herb. Vienna which bears the name *Arundinaria parvifolia* Hack.

Arundinaria pauciflora Keng, sp. nov.

Culmus in specimine circ. 40 cm longus, 3 mm crassus, internodiis in parte superiore teretibus, 4.5–9.5 cm longis, nudis, glabris, dense fasciculato-ramosus, ramis primariis usque ultra 20 cm longis et iterum ramulosis, racemos terminales plerisque gerentibus; vaginae ad ramulum floriferum ultimum pleraeque 3–6, imbricatae, glabrae vel ad collum et prope margines pubescentes, apice setis fuscis scaberulis saepe fimbriatae; ligula circ. 0.5 mm longa, truncata; laminae 1–3 cm longae, 3–6 mm latae, acuminatae, basi in petiolum brevissimum attenuatae, firmae, tessellatae, subtus glaucae, supra pubescentes, nervis secundariis utrinque 2–3, margine altero scabrae, altero fere cartilagineo-laeves; racemus inclusus vel demum breve exsertus, 2–3 cm longus, plerusque 3–spiculatus, pedicellis erectis, laevibus, 2–4 mm longis, bractea glumacea 2–3 mm longa saepe subtentis; spiculae 4–5-florae, 16–21 mm longae, leviter purpureae; glumae inaequales, glabrae vel interdum versus apicem ciliolatae, prima ovata, acuta, 3–4 mm longa, 1–3-nerva, secunda abrupte acuta, 6–7.5 mm longa, 7–9-nerva; lemmata ovato-lanceolata, acuminata, 7–9-nervia, reticulato-nervosa, glabra vel ad nervos puberula, infimo 8–12 mm longa, callo albo-pubescente; palea angusta, 7–8 mm longa, ad carinas superne ciliata; lodiculae 3, ovatae, 1.5–2 mm longae, fimbriatae; antherae 3, 5 mm longae, terminate exsertae; stigmata 2–3, plumosa, 2–3 mm longa; rhachillae articuli incrassati, 2.5–4 mm longi, margine apiceque ciliati, dorso item adpresso-pubescentes.

Type in the U. S. National Herbarium, no. 1128976, collected at Shaoshan, Ningyuen region, Szechuan Province, altitude 2700 meters, April 15, 1914, by Handel-Mazzetti (no. 1365).

This species is probably related to *A. brevipaniculata* Hand.-Mazz., but is distinguished by the racemes of a few spikelets.

BOTANY.—*A* Fusarium*-like species of* Dactylella *capturing and consuming testaceous rhizopods.*[1] CHARLES DRECHSLER, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry.

Agar plate cultures, started from diseased rootlets or other decaying plant materials that previously have been in prolonged contact with the soil, usually allow the gradual multiplication of various species of testaceous rhizopods, some of which often attain large numbers in the course of two or three weeks. Once a population of these animals has become established, it is in general less subject to rapid decline than the populations of animal types multiplying more

[1] Received August 31, 1936.

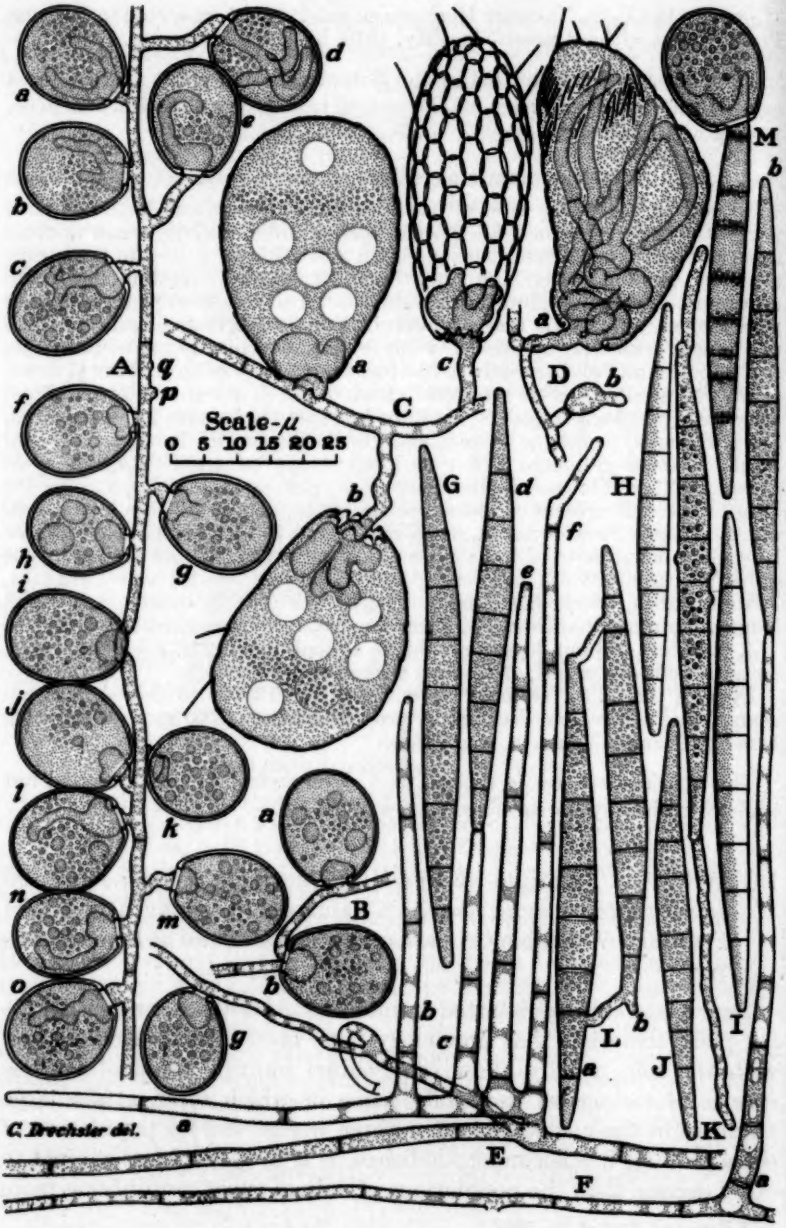


Fig. 1.—*Dactylella passalopaga*. For explanation, see opposite page.

rapidly in agar cultures, including, for example, many species of nematodes and many of the smaller amoebae. This lesser tendency toward abrupt reduction in number of living individuals, appears in considerable measure to be due to infrequence of destruction by parasitic or predacious fungi. In view of the disasters often overtaking populations of amoebae from the development of members of the Zoopagaceae (4, 5, 7) it might be expected that shelled rhizopods, whose protoplasmic bodies are necessarily partly protruded for feeding and locomotion, would suffer serious depredations from the same group of conidial Phycomycetes. Yet only two members of the Zoopagaceae, which will be described elsewhere, have so far been found to subsist on testaceous rhizopods. *Difflugia globulosa* Duj. and *Trinema enchelys* Ehrenb. were shown in an earlier paper (3) to be captured and consumed by *Pedilospora dactylopaga* Drechsl., a fungus referable to a quite different predacious series. This series, consisting of hyphomycetous forms belonging mostly to the genera *Trichothecium*, *Arthrobotrys*, *Dactylaria* and *Dactylella* (including *Monacrosporium*), is destructive mainly to nematodes. The biological relationship of *P. dactylopaga* would seem, therefore, to be a somewhat unusual one; as would also the similar relationship of an apparently allied fungus recently observed to subsist by the capture of two other species of shelled rhizopods.

The scanty vegetative mycelium of the fungus in question might readily be overlooked in a mixture of microorganisms but for the conspicuous alignment of captured prey in two ranks, with oral ends directed toward one another (Fig. 1, A-D). Because of the large numbers in which it develops in old agar plate cultures, the smaller

Fig. 1.—*Dactylella passalopaga*, drawn from material developed in mixed culture on maizemeal agar, with the aid of a camera lucida, at a uniform magnification; ×1000. A.—Portion of hypha on which fifteen specimens of *Geococcus vulgaris*, *a–o*, have been captured; the two slight protuberances *p* and *q*, possibly representing predacious modifications. B.—A short portion of hypha with two captured specimens of *G. vulgaris*; one, *a*, having been taken without positional disturbance of the filament; the other, *b*, having drawn the hypha partly into its mouth as in feeding. C.—Portion of hypha with three specimens of *Euglypha laevis*, each held by means of a lobed predacious gag; two of the animals, *a* and *b*, being shown mainly in optical section, the other, *c*, mainly in surface view. D.—Portion of hypha with (*a*) a captured specimen of *E. laevis*, within which are shown assimilative hyphae arising from the lobes of the predacious gag; and (*b*) an enlargement representing probably an outgrowth from which a rhizopod managed to escape. E.—Portion of mycelium showing an old, partly evacuated, prostrate conidiophore, *a*, that has given rise to four younger erect conidiophores, three of which, *b*, *c* and *e*, have each produced a single terminal conidium, and the other, *f*, in addition, a second conidium on the oblique distal prolongation; all the conidiophores being shown denuded except *c*, whereon conidium *d* is shown in position. F.—Portion of hypha with a conidiophore, *a*, bearing a conidium, *b*. G. H, I, J.—Detached conidia. L.—Two germinating conidia, *a* and *b*, the single germ tube from each having fused with a segment of the other conidium. M.—A conidium showing early predacious development following partial ingestion by a specimen of *G. vulgaris*.

rhizopod having a broadly ovoid, smooth test slightly thickened about the circular mouth, and otherwise corresponding well to Francé's description (8) of his *Geococcus vulgaris*, provides an especially striking display. Frequently the individual hyphae are beset for long stretches with the ovoid animals, here and there at such close intervals that the test of one will be in contact with that of its neighbor on either side (Fig. 1, A). A somewhat less abundant but still impressive display of predacious activity is furnished in the capture of an ovoid or often somewhat unsymmetrically bursiform species of *Euglypha*, measuring usually 35 to 50μ in length and provided with aperture scales noticeably thickened at their slightly incurved apices (Fig. 1, C, D). In morphology the animal evidently corresponds most closely to the description of *E. laevis* Perty as given in the accounts of Penard (13) and of Cash and Wailes (1); for though in some individuals a few rudimentary bristles may be present at the aboral end, a completely glabrous condition is by far more common.

Examination of tracts of mycelial filament free of the two species of rhizopods mentioned, has not revealed any distinct structure to which a special function in the capture of prey could be assigned. Some slight protuberances to be found now and then on vegetative hyphae (Fig. 1, A, *p*, *q*), or even on germinating conidia (Fig. 1, K), may possibly represent predacious modifications, but their meager differentiation is hardly at all suggestive of any important role. The swollen parts, sessile or stalked (Fig. 1, D, *b*), that are occasionally seen and that in some degree resemble the well defined predacious organs of *Dactylella tylopaga* Drechsl. (6) and of *Pedilospora dactylopaga*, are very similar to the processes formed after prey has been engaged, and in all probability represent outgrowths from which animals have managed to escape. An absence of definite organs of capture previous to encounter with prey, is unusual among the predacious Hyphomycetes, the only other example of such absence known in this series being found in the nematode-capturing species of *Dactylella* with quadrilobate conidia figured in another paper (2: Fig. 9, A, C).

The necessity for special organs to initiate capture is apparently obviated by the feeding habits of the animals on which the fungus preys. As *Geococcus vulgaris* is a relatively small testaceous rhizopod with a proportionately small aperture, it might be expected that feeding would be restricted to objects like bacteria and the more minute of fungus spores. Such limitation, however, does not actually prevail, for often the animal obtains its nourishment from objects as formidable as the oospore of *Pythium ultimum* Trow, which not only

exceeds it in size, but is surrounded, moreover, by the thick and thoroughly substantial oospore wall. Oospores of *P. ultimum* and of many congeneric forms are, of course, consumed by other rhizopods flourishing in agar plate cultures: some of the larger species of *Amoeba* often enveloping a specimen until the durable wall is broken down and the protoplasmic material assimilated; while the robust testaceous *Arcella vulgaris* Ehrenb., with its capacious oral aperture, often "imports" one specimen after another, so that three or four oospores in various stages of digestion may be seen inside. Neither of these more usual modes of ingestion is followed by *G. vulgaris*, which instead, applies its mouth flush to the oospore wall, calks the zone of contact with a yellow secretion apparently identical with the substance closing up the test during periods of encystment, and gradually perforates the delimited portion of spore wall, probably by some sort of digestive action. Once communication is established with the interior of the oospore, the granular contents, now visibly degenerating, are drawn into the test of the animal,—the movement of material appearing much the same as in the sucking of an egg.

When mycelium is attacked by *Geococcus vulgaris* the delay incident to the resistance of the thick oospore wall is obviated, and the sucking action becomes evident while the filament is still intact. No exception is made of the hyphae belonging to the predacious fungus herein under consideration, as a filament of this species is often to be seen drawn into the mouth of an animal (Fig. 1, A, *i;* B, *b*). To such undiscriminating voracity the fungus responds by rapidly proliferating from the partly ingested portion a bulbous outgrowth slightly larger than the oral aperture, so that the rhizopod is securely held. Indeed, more generally, the fungus meets the animal half way, by putting forth the expanded outgrowth before suffering any physical change itself. In many instances the expanded part is nearly sessile on the filament (Fig. 1, A, *a, b, c, f, g, h, j, k, l, n, o;* B, *a*), but in other instances it is formed on a short branch (Fig. 1, A, *d, e, m*). The rangier connection apparently is brought about when the animal, after making contact with the filament, moves away, and is pursued through elongation of the outgrowth until the expanded part has attained a width making further movement impossible.

The same sequence of events is followed also in the capture of *Euglypha laevis*. Because of the larger mouth of this rhizopod, a correspondingly bulkier gag is required to effect capture; the additional requirement being supplied through the proliferation of a number of expanded lobes (Fig. 1, C) in place of the simple distended part. Like-

wise, as might be expected, the assimilative hyphae thrust into the interior of the larger animal (Fig. 1, D, *a*) are longer and more numerous than those of the meager haustorial apparatus discernible, mostly with difficulty, in some specimens of *Geococcus vulgaris*. The exhaustion of materials from either rhizopod takes place without causing any sudden conspicuous change in appearance of the sarcode, the protoplasmic contents merely becoming more and more tenuous, much like the protoplasm of amoebae attacked by members of the Zoopagaceae, or like the contents of *Amoeba verrucosa* Ehrenb. attacked by *Dactylella tylopaga*.

After a mycelium has been nourished for some time, erect conidiophores arise singly (Fig. 1, F, *a*) or in small groups (Fig. 1, E, *b*, *c*, *e*, *f*) from the rangy prostrate filaments. They show unmistakable similarity to the homologous structures of *Pedilospora dactylopaga*, though noticeably stouter and shorter in stature. When growing in mixed culture in the presence of bacteria, the conidiophore usually concludes its development with the production of a single rather massive terminal conidium (Fig. 1, E, *d*; F, *b*). In some instances, however, it grows out from below the attachment of the first spore to produce a second farther on (Fig. 1, E, *f*); or, fairly often, it gives rise through lateral branching to one or more secondary conidiophores, under the increasing weight of which it is pressed down into a prostrate position. (Fig. 1, E, *a*). Though the conidium in its septation and elongate-fusoid shape bears a suggestive resemblance to the conidia of some species of *Fusarium*, it lacks the distinctive basal modification frequent in that genus, and is never borne on a sporodochium (Fig. 1, G–J). Germination takes place readily, by the production usually of two germ tubes, one from each end (Fig. 1, K). Anastomoses of germ tubes with detached conidia (Fig. 1, L, *a*, *b*) or with mycelial filaments, and, indeed, vegetative fusions generally, are frequent in this species, as in other members of the predacious series of Hyphomycetes. Occasionally newly detached conidia are partly ingested by *Geococcus vulgaris* (Fig. 1, M), so that at times vegetative germination may be preceded by predacious development.

The morphology of its conidial apparatus makes the fungus clearly eligible for inclusion in the genus *Dactylella* Grove. Of the several forms described in this genus, *D. minuta* var. *fusiformis* Grove (9) offers apparently the closest resemblance, though the greater diameter (7 to 9μ) and more abundant septation (9 to 12) ascribed to the conidia of the British species, would seem to exclude any strong likelihood of identity. Similarity in varying degree is recognizable also

when comparison is extended to the several species with narrow conidia that have been compiled in the genus *Monacrosporium* Oud. Thus *M. subtile*, as described and figured by Oudemans (12), approaches the predacious form under consideration in diameter of conidium, but presents fairly decisive differences in the clavate shape and more abundant septation of that structure. The pronouncedly clavate shape illustrated in Harz's original publication (10), together with the inferior length (35 to 38μ) and less abundant (3 to 5) septation, also sufficiently distinguishes the conidia of *M. sarcopodioides* (Harz) Berl. et Volg. On the other hand, the conidia of *M. oxysporum* Sacc. and March. (11) are described as being symmetrically spindle-shaped; yet their very acutely pointed ends emphasized in Marchal's drawings, their greater length (96 to 105μ) and width (9 to 10.5μ), and their more frequent (10 to 12) septation, not to mention the greater length (120 to 170μ) and width (4 to 5μ) of the supporting conidiophores, constitute details not reconcilable with the asexual reproductive apparatus found in my cultures.

The fungus so curiously adapted to prey on small-mouthed testaceous rhizopods is believed, therefore, to represent a new species, for which a name having reference to the gaglike predacious structure would seem appropriate.

Dactylella passalopaga sp. nov.

Mycelium sparsum, repens, parce ramosum; hyphis sterilibus 1.2–2.7μ crassis, hyalinis, mediocriter septatis, ex latere in ores animalium ramulum trudentibus qui intus tumet et sic animalia tenet; hyphis fertilibus paucis, solitariis vel parum aggregatis, hyalinis, plus minusve erectis, saepe 2–5-septatis, 40–110μ altis, basi 2.8–4μ crassis, sursum attenuatis, apice 1.2–1.8μ crassis, unicum conidium vel interdum secundum post incrementum ferentibus. Conidia hyalina, elongato-fusoidea, utrimque obtuse rotundata, 60–80μ longa, 4.5–6μ crassa, 6–8-septata.

Habitat in radicibus plantarum putrescentibus, in terra, saepe in humo silvarum, Geococcum vulgarem et Euglypham laevem capiens et consumens, prope Beltsville, Maryland.

Mycelium sparse, creeping, rather scantily branched; the vegetative hyphae 1.2 to 2.7μ wide, hyaline, septate at moderate distances, capturing some species of small-mouthed testaceous rhizopods by thrusting into the mouth of the individual animal a short lateral branch that expands inside to form a simple or lobed enlargement wider than the aperture; conidiophores usually few in number, scattered singly or in small groups, hyaline, more or less erect, mostly 2 to 5 (average 3.3) times septate, 40 to 110μ (average 69μ) in height, 2.8 to 4μ (average 3.3μ) wide at the base, tapering upward to an apical diameter of 1.2 to 1.8μ, bearing usually a single conidium and sometimes a second one on a distal prolongation originating immediately below the base of the first. Conidia hyaline, elongated spindle-shaped,

bluntly rounded at both ends, 60 to 80μ (average 69μ) long, 4.5 to 6μ wide, and divided usually by 6 to 8 (average 7.7) cross-walls.

Capturing and consuming *Geococcus vulgaris* and *Euglypha laevis*, it occurs in decaying plant roots, in soil, and especially often in leaf mold, near Beltsville, Maryland.

LITERATURE CITED

1. CASH, J., and WAILES, C. H. *The British fresh-water Rhizopoda and Heliozoa.* 5 vols. London, 1905–1921.
2. DRECHSLER, C. *Morphological diversity among fungi capturing and destroying nematodes.* This JOURNAL **23**: 128–141. 1933.
3. DRECHSLER, C. Pedilospora dactylopaga n. *sp., a fungus capturing and consuming testaceous rhizopods.* This JOURNAL **24**: 395–402. 1934.
4. DRECHSLER, C. *Some conidial Phycomycetes destructive to terricolous amoebae.* Mycologia **27**: 6–40. 1935.
5. DRECHSLER, C. *Some non-catenulate conidial Phycomycetes preying on terricolous amoebae.* Mycologia **27**: 176–205. 1935.
6. DRECHSLER, C. *A new mucedinaceous fungus capturing and consuming* Amoeba verrucosa. Mycologia **27**: 216–223. 1935.
7. DRECHSLER, C. *New conidial Phycomycetes destructive to terricolous amoebae.* Mycologia **28**: 363–389. 1936.
8. FRANCÉ, R. H. *Das Edaphon.* 99 p. Munich, 1913.
9. GROVE, W. B. *New or noteworthy fungi:* Part III. Jour. Bot. **24**: 129–137, 197–206. 1886.
10. HARZ, C. O. *Einige neue Hyphomyceten Berlin's und Wien's nebst Beiträgen zur Systematik derselben.* Bull. Soc. Imp. Nat. Moscou **44**: 88–147. 1871.
11. MARCHAL, E. *Champignons coprophiles de Belgique.* Bull. Soc. Roy. Bot. Belgique **24**: 57–77. 1885.
12. OUDEMANS, C. A. J. A. *Aanwinsten voor de flora mycologica van Nederland, IX en X.* Nederl. Kruidk. Arch. II **4**: 203–278. 1885.
13. PENARD, E. *Faune rhizopodique du bassin du Léman.* 714 p. Geneva, 1902.

ZOOLOGY.—*New millipeds of the American family Striariidae.*[1] H. F. LOOMIS, U. S. Plant Introduction Garden, Coconut Grove, Florida. (Communicated by O. F. COOK.)

The milliped family Striariidae is composed of a single genus containing species found only in the United States. The first species was described in 1888 by C. H. Bollman, who recognized it as the type of the genus *Striaria*, later designating a new subfamily for its accommodation. In 1895 O. F. Cook elevated the subfamily to full family rank, and in 1896 gave it position as a suborder of the Coelocheta, on the same footing as the Lysiopetaloidea and the Chordeumoidea, like the Chordeumoidea in the short body of 30 segments, and like the Lysiopetaloidea in having the segments longitudinally carinate, but contrasting with both these groups in the slow movements and heavily armored structure, with the head reduced and protected by the greatly expanded first segment, the lower carinae strongly developed, and the last segment broadly three-lobed, affording protection when the animals are coiled, as in several specialized families of the order Merocheta.

[1] Received June 18, 1936.

In 1899 Cook formulated descriptions of the order, its three subdivisions, and of the family, genus and type species, *Striaria granulosa* Bollman, and also added two new species, one from the District of Columbia, while the other, based on a female specimen, extended the distribution of the group to California. The next and last addition to the genus was made by R. V. Chamberlin, in 1910, of another species, from Portland, Oregon, also based on a female specimen.

In the material which led to the preparation of the present paper were two new species, both from California, giving a preponderance

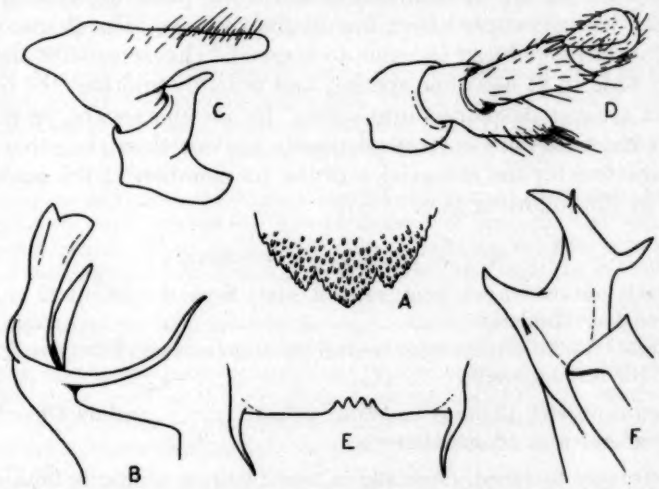


Fig. 1.—Structural features of *Striaria*. A. *S. nana*, last segment. B. *S. nana*, lateral view of apical two-thirds of anterior portion of a gonopod. C. *S. nana*, left posterior gonopod from behind. D. *S. imberbis*, second leg of male. E. *S. californica*, labrum of male. F. *S. californica*, lateral view of apex of anterior gonopod.

to the Pacific Coast. Also there were many specimens of *S. californica* Cook, from the males of which it has been possible to amplify the original description of the species.

The characters shown by the new species, and additional specimens of some of those previously known, force the modification of several statements which have been made pertaining to the characters of the genus *Striaria* or higher classification units. Dorsal setae, in the same number and position as in the Chordeumoidea, were found in four species examined and are inferred to be present in those not seen. Only in specimens of *S. nana* were these setae found in complete series, but careful inspection of examples of the other species us-

ually showed a few setae still remaining on some of the segments, especially those near the ends of the body, although most of the setae had been broken off. The disposition of these setae is as follows: On the first segment six setae are found a little back of the front margin, in front of the dorsal crests. The ensuing segments also have six dorsal setae, three on each side of the dorsum, the first located between ridges 1 and 2, the second between ridges 3 and 4, and the third between ridges 5 and 6. Segment one and the last segment are without a median ridge, while the other segments have a pronounced ridge on the anterior subsegment but none on the posterior subsegment, its place being occupied by a fine distinct groove. The shape of the male labrum is reduced in value to a specific character with the discovery that in at least one species, and possibly another, the lateral corners are not developed into spines. In one species the pregenital legs of the males are not conspicuously heavier than the other legs.

Characters for the recognition of the six members of the genus are given in the following key.

KEY TO THE SPECIES OF STRIARIA

Size small, not over 7 mm long; ventral crests beyond segment 12 or 13 reduced or obsolete..... **nana** n. sp.

Size larger, at least 10 mm long; ventral crests present on all but two or three of the last segments.....

First segment with 12 dorsal crests or ridges.....**nazinta** Chamberlin

First segment with 10 dorsal crests.....

Body strongly flattened, especially in front; labrum similar in both sexes; second male legs with a very large lobe projecting from beneath the second joint.....**imberbis** n. sp.

Body cylindrical or only slightly flattened; labrum of males with lateral corners produced into long spines; second male legs with lobes small or wanting.....

Body reaching 15 mm in length; males with the anterior margin of the labrum nearly straight between the median teeth and the produced spine on either side.....**californica** Cook

Body less than 12 mm long; male labrum with anterior margin strongly convex between the median teeth and the lateral spines.....

Dorsal crests very coarse; lobes of the last segment separated by distinctly open sinuses; apex of anterior gonopods terminating in about six short spines or teeth.....**granulosa** Bollman

Dorsal crests finer; lobes of the last segment separated by shallow notches rather than by deep and slender sinuses; apex of anterior gonopods terminating in about a dozen sharp teeth.....**columbiana** Cook

Striaria nana n. sp.

Six mature specimens, including the male type, and several young, collected at Altamont Pass, above Niles, Calif., December 1, 1926, by O. F. Cook, who found a single female south of Pescadero, Calif., February 21, 1929. Male type in U. S. National Museum.

Diagnosis: The small size of the body; presence of all or nearly all dorsal setae; the lack of ventral crests on the posterior half of the body; and the shape of the gonopods distinguish this species.

Description: Body small, the dorsum somewhat depressed on the first few segments, but cylindrical thereafter; dorsal setae generally all present; length 6 to 7 mm, width .7 to .8 mm.

Head with not over 7 ocelli each side. Labrum of male broad, outer corners sharply angled but, unless broken from the two specimens examined, without spines.

First segment with 10 dorsal crests; surface elsewhere finely and densely granular as are the ensuing segments, including their lateral surfaces. Median ridge of the anterior subsegments fine but well elevated, the depression on either side of its posterior part much less extensive than in *S. californica* or *S. imberbis*.

Second segment with the surface bearing the ventral crest scarcely at all produced outward beyond the line of descent of the side, not forming a nearly horizontal projecting shoulder as in *S. imberbis*. Interval between the ventral crest and the lowest dorsal crest a little wider than the next interval above.

Large ventral crests present on the segments in front of the middle of the body, the anterior corner of each crest slightly produced forward and bluntly rounded; on the posterior segments the ventral crests are reduced to small low elevations or are entirely lacking. Last segment with the lateral lobes smaller in proportion to the median lobe than in the other species, and all lobes more acute; dorsal surface covered with slender suberect tubercles (Fig. 1, A).

Males with first pair of legs stouter than the second pair. Second legs lacking a conspicuous lobe on the under side of joint 2, the other joints also normal. Third legs with each coxa produced into an erect subcylindric lobe relatively as long as found in *S. granulosa*, the inner face glabrous and shining, the outer side finely hispid; remaining joints normal. Legs 4 to 7 with the four basal joints very greatly expanded horizontally but not thickened, their surface covered with short, stout, fusiform, almost scale-like hairs, in contrast to the common type of hairs found on the other legs. Anterior gonopods with the apex bilobed, not at all spinose (Fig. 1, B). Posterior gonopods with the distal joint more greatly produced inward than in the other species, the lobe thinner (Fig. 1, C).

This small species was at first thought to represent a new genus because of the presence of dorsal setae in the same position as they occur in the Chordeumoidea, but careful inspection of other species of *Striaria* showed nearly all individuals to have a few dorsal setae still in evidence, although it was apparent that most of the setae had been broken off. Immature specimens of these species show the setae in more complete series.

STRIARIA NAZINTA Chamberlin

Ann. Ent. Soc. Amer., **3**: *242-243. 1910.*

A single female, discovered at Portland, Oregon, is the only known specimen.

The presence of 12 dorsal ridges on segment 1 is the species' most striking character, 10 ridges being the usual number in the other species, with occasionally an additional, small, rudimentary ridge on one or both sides of this segment in some specimens.

Although the description states that the labrum has only two teeth, and the illustration shows this condition, it is doubtful if other specimens exhibiting this feature would be found, since a three-toothed labrum is an ordinal character of the Coelocheta.

Striaria imberbis n. sp.

A mature male and female and a number of young, the eldest of which have 26 segments, collected south of Atascadero, Calif., January 1, 1928, by O. F. Cook. Male type in U. S. National Museum.

Diagnosis: This species is distinguished by the flattened dorsum; the similarity of the labrum in both sexes; the unusually prominent lateral production of each side of segment 2 supporting the ventral crest; and the very large lobe of the second joint of the second male legs.

Description: Length of male 10 mm, female 12 mm, width 1 and 1.2 mm respectively.

Head narrower in front than in the other species; labrum of the male similar to that of the female, the lateral corners broadly rounded; ocelli 5 to 7 arranged in two irregular rows.

Second segment with the lateral surface which supports the ventral crest much more strongly projecting than in the other species, the interval between the marginal crest and the lowest dorsal crest double the width of the next interval above. Dorsum of the segments depressed throughout, but the anterior ones more strikingly so. Posterior subsegments relatively longer than in the other species. Dorsal crests high but much thinner than those of *S. columbiana*. Surface between the crests with numerous granules on the anterior segments but caudally the granules decreased in size and number; on the lateral surfaces only the anterior segments have a few granules; however, the last segment is densely covered with fine granules. Ventral crests extending to the posterior end of the body, those in front with the anterior corner projecting forward as a large acute tooth. Median ridge very prominent on the anterior subsegments, especially those in front, the depression on either side of its back half is more extensive than that in *S. californica*. Last segment with the lobes very narrowly, although deeply, separated, the median lobe much the largest.

Gonopods of the type not dissected but the apex of the anterior portion does not appear to be spinose; the shoe-like posterior joints are of the same general shape as in the other species. First legs of the male stouter than the second pair; the latter with a very large, bluntly conic lobe projecting outward and backward from the under side of the second joint, the posterior side and apex with long hairs (Fig. 1, D); other joints normal. Coxal lobes

of the third male legs considerably shorter than in the other species of which males are known. Legs 4 to 7 of the male with none of the joints conspicuously enlarged as compared with the post-genital legs, their surfaces invested with similar hairs.

STRIARIA CALIFORNICA Cook

Proc. U. S. Nat. Mus., **21**: *675. 1899.*

Specimens collected by O. F. Cook in the following California localities have been examined: Santa Cruz Mts., Jan. 2, 1928; Cordelia, Feb. 20, 1929; Davenport, Feb. 21, 1929. Several males are included which allow more tangible characters to be given than from the single female on which the species was founded.

Body attaining a length of 15 mm, making the species the largest of the genus.

Eyes with 7 to 9 ocelli. Males with the labrum produced at each corner into a long spine, the margin between the spine and the median teeth almost straight in contrast with the strongly convex margin of the other species (Fig. 1, E).

Segment 1 and a few segments succeeding it rather thickly and coarsely granular, the granules thereafter decreasing in size and number and, except those bearing the dorsal setae, none are evident on the segments immediately preceding the anal segment, the surface of which is densely but finely granular. Sides of body without granules after the first few segments. Anterior subsegments, particularly those at the front of the body, with a median ridge which is especially pronounced on the posterior part of each subsegment, and the surface on each side is depressed to the level of the posterior subsegment which has a fine median furrow but no ridge. Second segment with the lateral surface supporting the ventral crest scarcely at all produced outward to form a strong shoulder as in the other species; the interval between the ventral crest and the lowest dorsal crest little broader than the interval between crests 5 and 6. Ensuing segments, to near the posterior end of the body, with thick ventral crests, those on the anterior segments bluntly produced forward.

Gonopods with the apex of the anterior portion more simple than in either eastern species (Fig. 1, F); shoe-like joint of the posterior portion thickest near its mesial extremity. The second male legs have joint 2 bearing a much smaller, more inconspicuous lobe on the under side than that in *S. imberbis*, but with longer apical hairs; joint 3 greatly swollen except at base; outer joints normal. The third male legs have the coxal lobes longer than in the other species, their tips exceeding the distal end of joint 3. Male legs 4 to 7 with the inner joints quite strongly crassate, the outer joints more normal.

STRIARIA GRANULOSA Bollman

Ann. N. Y. Acad. Sci., **4**: *108. 1888.*

Locality: Tennessee.

STRIARIA COLUMBIANA Cook

Proc. U. S. Nat. Mus., **21**: *674–675. 1899.*

Localities: District of Columbia and Maryland.

ZOOLOGY.—Anguillulina askenasyi (*Bütschli, 1873*), *a gall forming nematode parasite of the common fern moss,* Thuidium delicatulum (*L.*) *Hedw.*[1] G. STEINER, Bureau of Plant Industry.

There are quite a few records of the occurrence of nematode galls on mosses from Europe, but, as far as known to the writer, there are no such records from this country. All previous observations were

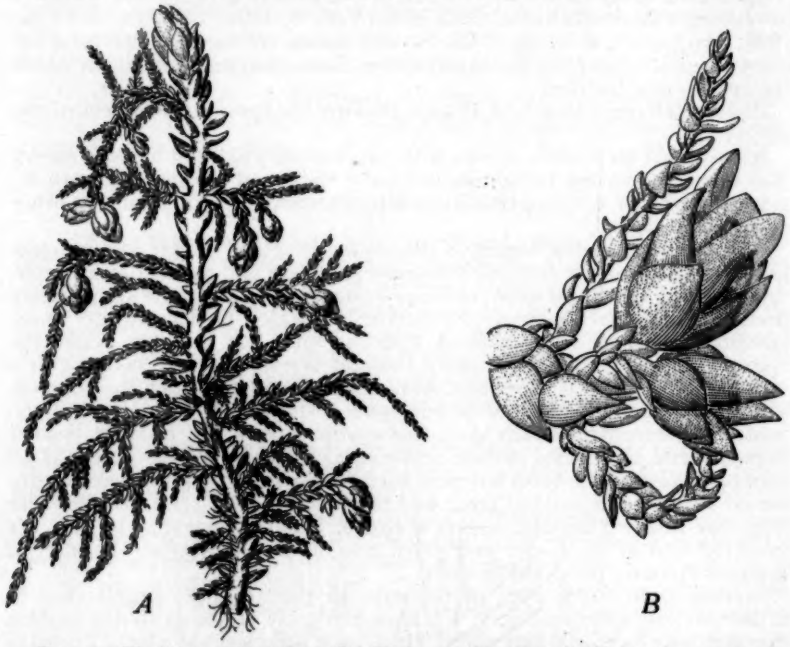


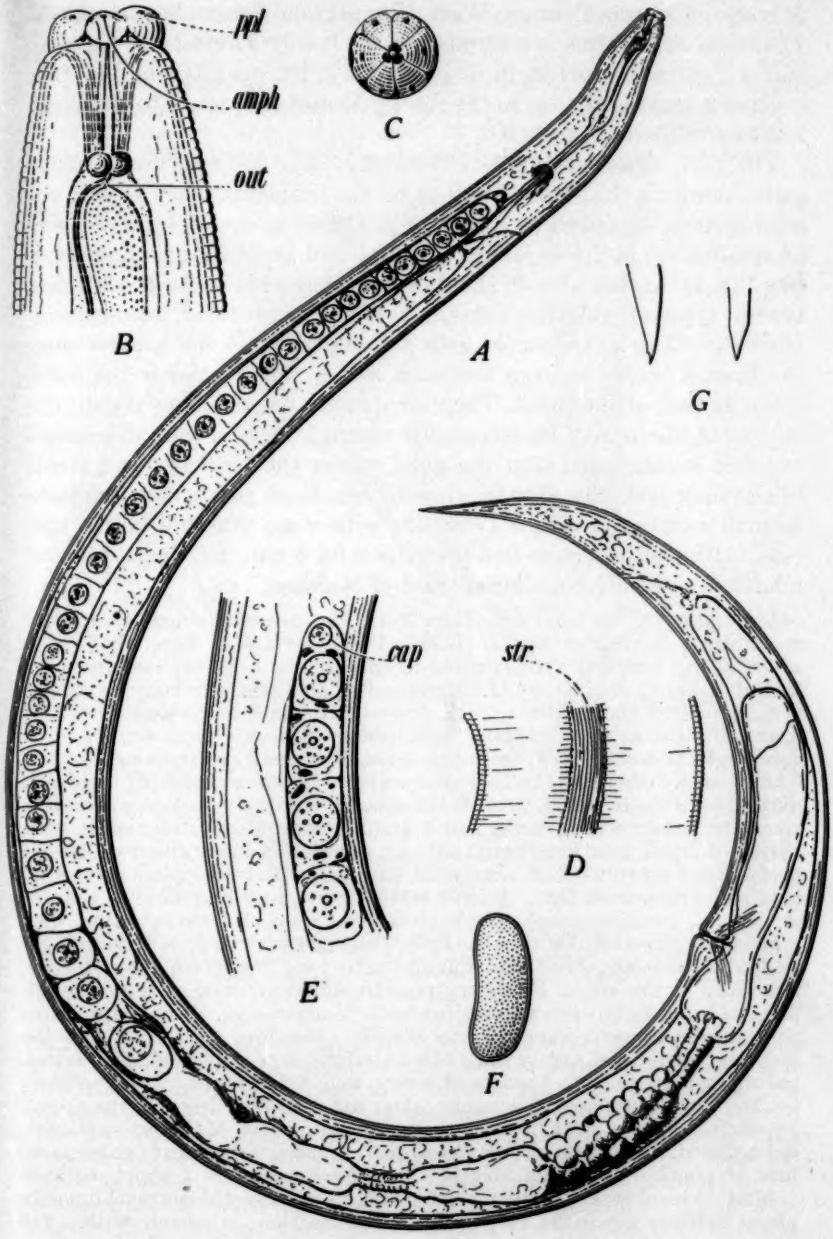
Fig. 1.—*Thuidium delicatulum* (L.) Hedw. with galls caused by the nematode *Anguillulina askenasyi* (Bütschli). *A*, stem and branches with terminal galls. ×6. *B*, detail of two galls. ×24.

summarized in 1906 by Schiffner and further additions reported later by Horn (1909).

Through Mr. J. L. Sheldon of Morgantown, West Virginia, a sample of *Thuidium delicatulum* with galls was received with the inquiry as to the name of the nematode species present. The moss had been collected in a wood across the road from the old Iron Furnace, near

[1] Received June 5, 1936.

Fig. 2.—*Anguillulina askenasyi* (Bütschli). *A*, female. ×370. *B*, head end of female; *amph*, amphid; *ppl*, cephalic papilla; *out*, outlet of dorsal esophageal gland. ×1900. *C*, front view of head of male. ×1900. *D*, striated lateral field in adult; *str*, striae. ×1900. *E*, proximal end of ovary; *cap*, cap cell. ×730. *F*, egg. ×250. *G*, variations in terminus of tail. ×330.



For explanation of Fig. 2 see bottom of opposite page.

Albright, Preston County, West Virginia, on September 21, 1935. *Thuidium delicatulum* is a member of the family *Thuidiaceae* (*Musci*) and is a species occurring in moist woods in Europe, Asia and on this continent from Labrador to the Rocky Mountains, south to the West Indies and South America.

The galls, measuring .680–.716 mm by .868–.877 mm, are terminal galls, found on the stem as well as on the branches. They closely resemble those described by Massalongo (1898) as caused by *Tylenchus* (*Anguillulina*) in *Zieria julacea* Schimp., and are of the artichoke type (see Fig. 1), having no side shoots or any resemblance to the witches broom type of galls as described from some other mosses, e.g. *Dicranum*. The leaves on the galls are enlarged to a size greater than the branch leaves or even the stem leaves. Their color is the same green as that of the plant. They are densely set on the oval gall, the outline of which may be recognized through them. From all appearances it is concluded that the galls render the branches and stems blind; they probably drop in a later stage. Each gall usually contains a small number of adults (7 to 12) with some 200–300 larvae and eggs. Although the moss had been dried for 8 months, the larvae and adults revived after a short period of soaking.

Description of the nematode (Figs. 2–3). The present parasite markedly resembles *Anguillulina dipsaci* (Kühn, 1858) Gerv. & v. Ben., 1859, with which it was formerly synonymized in spite of the clear-cut statement by Bütschli that it is different (J. Ritzema Bos and al.). The body, however, is much stouter than in the true *A. dipsaci*, although the present specimens were not quite as stout as those described by Bütschli under the name *A. askenasyi* (Bütschli, 1873) from the moss, *Hypnum cupressiforme* Hooker. Cuticle with rather fine annulations, 1μ wide; tail pointed, sharply in adults, much less in the larvae. Lateral fields about 1/5 of body diameter in width; larvae with two edging striae and a middle longitudinal stria; adult with about 10 much finer longitudinal striae; annulation interrupted on lateral fields. Head sharply set off, somewhat rounded, with rather plain submedial papillae. Framework light. Buccal stylet short, finer and smaller than in *A. dipsaci*. Terminal esophageal bulb distinctly set off from intestine, with esophageal glands still within the bulb. Intestine with large cells, seemingly in double alternate series. Rectum and anus very fine, often even obscure, especially in the adult. Excretory pore in adults ventrad of terminal esophageal bulb; in larvae ventrad just back of nerve-ring. Female apparatus with postvulvar sac-shaped uterus usually extending more than half the distance vulva-anus. Ovary most often straight, rarely reflexed, with terminal cap cell (Fig. 2, E). Outlets of ovary well differentiated, with oviduct leading into receptaculum seminis; latter differentiated from uterus proper by distinct narrow duct. Eggs deposited unsegmented. Male testis straight, not reflexed. Spicula much like those of *A. dipsaci*, with lineate gubernaculum of about 1/3 spicula length. Bursa rises suddenly a short distance behind, or level with, proximal spicula end, in most specimens reaching only about halfway down the tail, rarely a little farther; in a male with a tail

of 103μ, it extended to a distance of 64μ back of the anus. *A. askenasyi* is considered a good species and is herewith reestablished. The original form was observed only once, namely by Bütschli, in Germany, on the moss, *Hypnum cupressiforme*, where, according to this author, it induces certain transformations in terminal buds, without, however, producing galls. It lives between the leaves of the buds of this moss. Although resembling *dipsaci*, it differs from it by being stouter, by having a longer esophagus, in

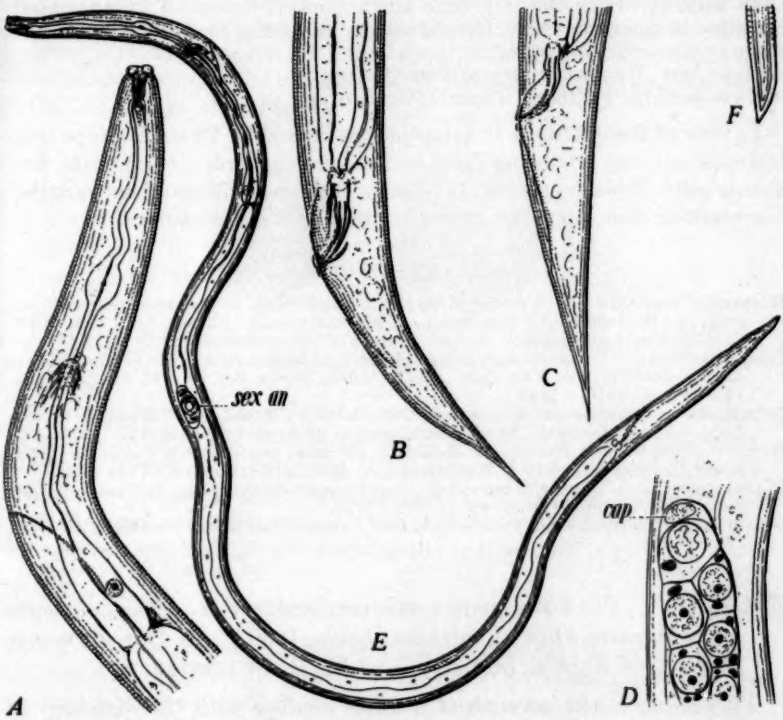


Fig. 3.—*Anguillulina askenasyi* (Bütschli). *A*, anterior end. ×420. *B* and *C*, two different male tail ends; in *C* the bursa beginning farther back than in *B*. ×420. *D*, proximal end of testis; *cap*, cap cells. ×640. *E*, larva of .648 mm length; *sex an*, sexual anlage. ×330. *F*, terminus of larval tail. ×640.

both sexes a longer tail, an intestine of brownish color, and a shorter bursa in the male which reaches only about halfway, or slightly farther, down the tail. In addition the vulva has a more anterior position. Adults of the present species usually take a "more or less rolled-up" spiral position.

Gall forming nematodes in mosses in the past have been referred to *Anguillulina davainii* (Bastian, 1865); whether correctly or not cannot be stated at present, the published descriptions being rather incomplete.

Measurements of specimens from Thuidium delicatulum: ♀ (n 10) total length = .980–1.2 mm; α = 23–31, β = 8–11.5, γ = 8.5–12.8, v = 73%–78%.

Distance vulva-anus = about twice length of tail; eggs 36–41μ×80–100μ; stylet 8–10μ. ♂ (n 5) total length = .92–1.2 mm; α = 24–31, β = 8.1–10.7, γ = 8.5–14.5; spicula about 30μ; gubernaculum 8–10μ; stylet 8–10μ.

Measurements as given by Bütschli for the type form: ♀ = 1.7 mm; α = 19, β = 10, γ = 13; v = 80%; eggs = 50μ×95μ; stylet = 13μ. ♂ = 1.4 mm; α = 20, β = 10, γ = 12.

Emended diagnosis of A. askenasyi: Resembling *A. dipsaci* but stouter, vulva more cephalad, bursa shorter, reaching only half, or slightly more than halfway, down the tail; eggs much thicker, deposited unsegmented; intestine of brownish color; female usually assuming shape of a sickle or a more or less rolled-up spiral.

Type host: Hypnum cupressiforme Hooker.

Type locality: Feldberg, Taunus (Germany).

In view of the difference in symptoms as caused by Bütschli's type form (ectoparasite, not producing galls) and the present form (entoparasite, producing galls), it is thought best to consider the two as different host varieties, a conception also supported by slight differences in dimensions.

LITERATURE CITED

BASTIAN, CHARLTON H. *Monograph on the Anguillulidae, or free nematoids, marine, land, and freshwater, with descriptions of 100 new species.* Trans. Linn. Soc. **XXV**: 73–179, Pls. 9–13. 1865.

BOS, J. RITZEMA. *L'anguillule de la tige* (Tylenchus devastatrix *Kühn*) *et les maladies des plantes dues à ce Nematode.* Arch. Musee Teyler Ser. II, Vol. III, 2e partie: 161–348, pl. 1–10. 1888.

BÜTSCHLI, O. *Beitrage zur Kenntniss der freilebenden Nematoden.* Nova Acta Ksl. Leop.—Carol. Deutsch. Akad. Naturforscher **36**(5): 1–144, pl. 1–11. 1873.

HORN-WAREN, PAUL. *Beitrag zur Kenntniss der moos bewohnenden Tylenchus-Arten.* Arch. Ver. der Freunde d. Naturgesch. in Mecklenburg. **63**: 67–77. 1909.

MASSALONGO, C. *Nuovo Elmintocecidio scoperto sulla Zieria julacea Schimp.* Rivista Patologia Vegetale **7**(1): 87–89. pl. IV. 1898.

SCHIFFNER, VICTOR. *Neue Mitteilungen über Nematoden-Gallen.* Hedwigia **45**: 159–172. 1906.

ZOOLOGY.—*The histology of nemic esophagi. VII. The esophagus of* Leidynema appendiculatum (*Leidy*, 1850.)[1]

B. G. CHITWOOD, Bureau of Animal Industry, and M. B. CHITWOOD.

This paper is the seventh of a series dealing with the histology of nemic esophagi. In the earlier papers (1934–1936) the esophagi of *Rhabdias eustreptos, Oesophagostomum dentatum, Heterakis gallinae Metastrongylus elongatus, Rhabditis terricola* and *Rhabditis lambdiensis* have been described. The nomenclature used in this paper was explained in the first paper of the series.

GROSS MORPHOLOGY

The length of the esophagus of *Leidynema appendiculatum* usually ranges from 396 to 448μ in the gravid female, but in the gravid female upon which subsequent measurements are based, it is 364μ long. It consists of a cylindri-

[1] Received March 13, 1935.

cal precorpus, 126μ long, a subcylindrical postcorpus, 108μ long, a very short narrow isthmus, 36μ long, and a pyriform bulb, 64μ long. The lumen is triradiate; in the corpus and isthmus each radius terminates in an incomplete subcylindrical "tube." The "tubes" are very wide in the precorpus (Fig. 2a), very narrow in the postcorpus (Fig. 2c), and scarcely distinguishable in the isthmus. In the bulb region the sides of the radii converge; in this region the lumen is, of course, modified by the valves. Returning to the lumen of the corpus, we find that in the precorpus the central part of the lumen is open, subtriangular with thickened walls (Fig. 2a–b), while in the postcorpus and isthmus the lumen is closed, not subtriangular and the walls not thickened (Figs. 1b and 2c–d).

Fig. 1.—Cross section of esophagus. a, Region of precorpus in adult; b, region of postcorpus in adult.

The esophagus of the female fourth-stage larva in the specimen studied is 218μ long and consists of the same parts as in the adult, i.e., precorpus, postcorpus, isthmus and bulb, but the postcorpus is not as wide and the isthmus is very slightly longer. In addition we find that the "tubes" at the ends of the esophageal radii are not as large, the lumen of the precorpus not subtriangular, and its walls not thickened as in the adult.

NUCLEAR DISTRIBUTION

The distribution of nuclei in the esophagus differs slightly in the fourth-stage larva and in the adult. In general, the nuclei are closer together in the larva than in the adult, which is due to the esophagus being shorter; a few of the nuclei differ also in relative position. The nuclei are identical in both stages and for that reason the esophagus of the adult is described, differences in relative position being noted as they occur.

Precorpus.—There are 25 nuclei in the precorpus as follows: 6 radial nuclei (r_{1-6}) and 19 nerve cell nuclei (n_{1-19}). The radial nuclei are situated near the base of the precorpus, and arranged in a single group (r_{1-6}), 1 nucleus on each side of each sector. The nerve cell nuclei are arranged in groups of 3, one in the center of each sector. The first group (n_{1-3}) is situated near the anterior end of the precorpus, the second, third, and fourth groups, (n_{4-6}, n_{7-9}, and n_{10-12}), respectively, follow one another rather closely in series. These are followed by the fifth group (n_{13-15}) which immediately precedes the radial nuclei of the precorpus (r_{1-6}) and the sixth group (n_{16-18}) which is situated

at about the same level as the radial nuclei. The nuclei n_{13} and n_{16} may be identical but in the majority of sections they appear to be separate. In addition to these nuclei there is a single dorsal nerve cell nucleus (n_{19}) situated posterior to n_{17}. In the fourth-stage larva the last 2 subventral nerve cell nuclei are situated at the level of n_{19} instead of at the level of n_{17}. The radial nuclei (r_{1-6}) are situated near the level of n_{10-15} instead of n_{13-18}.

Postcorpus.—There are 22 nuclei in the postcorpus as follows: 3 bilobed marginal nuclei ($m_{1-3a \text{ and } b}$), 6 radial nuclei (r_{6-12}), and 13 nerve cell nuclei (n_{20-32}). The radial nuclei (r_{7-12}) are situated anterior to the middle of the postcorpus and arranged in the same manner as those (r_{1-6}) in the

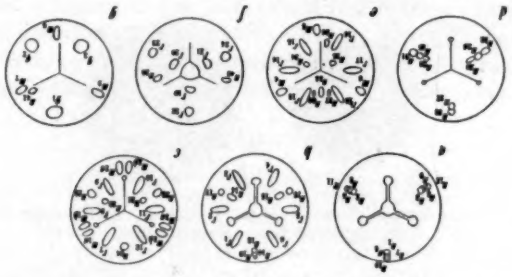


Fig. 2.—Diagrammatic representation of groups of nuclei of esophagus. a–b, Precorpus; c–d, postcorpus; e, prevalvar region; f–g, valvar and postvalvar regions.

precorpus. The marginal nuclei (m_{1-3}) are situated at approximately the same level, 1 lobe of a nucleus being on each side of each esophageal radius (Fig. 1b, m_{1a} and m_{1b}). The nerve cell nuclei (n_{20-32}) are arranged symmetrically in the subventral sector but not in the dorsal sector and for that reason they will be located according to sector. The dorsal sector contains 3 nuclei ($n_{24,27,30}$) the first (n_{24}) being at the level of the radial nuclei (r_{7-12}), the second (n_{27}) some distance posterior to the radial nuclei, and the third (n_{30}) at the base of the postcorpus. Each subventral sector contains 5 nerve cell nuclei ($n_{20-21,22-23,25-26,28-29,31-32}$). The first pair ($n_{20-21}$) is situated slightly anterior to the level of the radial nuclei, near the lumen of the esophagus, and the second pair (n_{22-23}) is situated at the same level or slightly posterior to the first pair and nearer the external surface of the esophagus. The third subventral pair (n_{25-26}) is situated just anterior to the level of n_{27}; the fourth pair (n_{28-29}) is situated posterior to the level of n_{27}, being near the external surface of the esophagus; the fifth pair (n_{31-32}) is at approximately the same level as, or slightly posterior to, the fourth group (n_{28-29}). The nerve cells in the fourth-stage larva differ in that n_{20-23} are situated at the level of r_{7-12}, n_{25-26} at the level of n_{27}, and n_{31-32} at the level of n_{30}.

Isthmus.—The isthmus contains no nuclei.

Prevalvar and valvar region.—This region contains 20 nuclei as follows: 9 radial nuclei (r_{13-21}), 3 marginal nuclei (m_{4-6}), and 8 nerve cell nuclei (n_{33-40}). The radial nuclei are arranged in 2 groups, an anterior group of 6 nuclei (r_{13-18}) arranged as are those in the corpus (r_{1-12}), and a posterior group of 3 nuclei (r_{19-21}), 1 near the center of each sector. The nerve cells are arranged as follows: n_{33} in the middle of the dorsal sector just posterior to the level of $r_{13 \text{ and } 18}$; $n_{34 \text{ and } 35}$ near the middle of each subventral sector at the same level as n_{33}; n_{36-37} are situated just posterior to n_{33}, 1 on each side of the

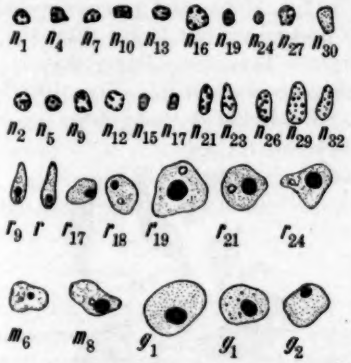


Fig. 3.—Nuclei of esophagus. Marginal, radial, gland nuclei and nuclei of nerve cells.

dorsal sector; n_{38} is situated near the ventral radius in the right subventral sector at approximately the same level as r_{21}; n_{39-40} are situated posterior to r_{14-17}, respectively, 1 in the lateral part of each subventral sector.

Postvalvar region.—The postvalvar region contains 10 nuclei as follows: 3 radial nuclei (r_{22-24}), 3 marginal nuclei (m_{7-9}), 3 gland nuclei (g_{1-3}), and 1 nerve cell nucleus (n_{41}). The marginal nuclei (m_{7-9}) are situated near the anterior end of the postvalvar region, 1 being posterior to the other 2. One is situated near each esophageal radius, the side at which each nucleus lies being inconstant. The radial nuclei (r_{22-24}) are situated slightly posterior to the marginal nuclei, 1 near the lumen and in the center of each sector. The gland cell nuclei (g_{1-3}) are similarly arranged except that they are posterior to the radials and near the external surface of the esophagus. The single nerve cell nucleus (n_{41}) is situated beside the left subdorsal radius of the esophagus at about the level of the gland cell nuclei.

THE ESOPHAGO-INTESTINAL VALVE

The esophago-intestinal valve consists of an internal trilobed mass of tissue and an external circular layer of tissue. Within the trilobed mass are

2 nuclei, 1 dorsal (e_1) and 1 ventral (e_2). The number of nuclei in the external layer could not be determined with accuracy. Three nuclei, 1 left and 1 right dorsolateral (e_{3-4}) and 1 right or left subventral (e_5), were consistently found. Two additional dorsolateral nuclei (e_{6x-7x}) were found external to e_{3-4} in one specimen. However, it is possible these nuclei might be those of intestinal cells.

CHARACTER OF NUCLEI

The radial nuclei all contain a moderately large karyosome. The nuclei of the precorpus (r_{1-6}) are laterally compressed, and have a clear, lightly basophilic nucleoplasm (Fig. 1a). The second group of radial nuclei are similar in shape to those of the first group but larger (Fig. 1b). The nucleoplasm is slightly less basophilic, the karyosome larger than the karyosomes of r_{1-6}, and a smaller plasmosome is often visible (Fig. 1b). The nuclei of the third group of radials (r_{13-18}) are similar to those of the second group but more or

Fig. 4.—Nerve cells.

less ovoid; the nucleoplasm is lightly basophilic, nearly homogenous and each also contains a moderate-sized karyosome and a smaller plasmosome (Fig. 3). The nuclei of the fourth group (r_{19-21}) are rounded in shape, distinctly larger than the others, and each contains a very large karyosome as well as a small plasmosome (Fig. 3). The nuclei of the fifth group (r_{22-24}) are similar to those of the fourth group, but tend to be slightly flattened (Fig. 3).

The marginal nuclei are similar to the radials in general character but the nucleoplasm appears to be more reticular (Fig. 3). Each of the marginal nuclei of the postcorpus (n_{1-3}) consists of a posteriorly bilobed body which in cross section appears as 2 nuclei (Fig. 3), each containing a moderate-sized karyosome and a small plasmosome. The marginal nuclei (m_{4-6}) are not lobed but tend to be irregular in shape due to pressure from the marginal fibers; each contains a large karyosome and a small plasmosome (Fig. 3a). The marginal nuclei (m_{7-9}) are ovoid and similar to m_{4-6}.

The nuclei of the esophageal glands (g_{1-3}) are similar in general character to those of the radial nuclei r_{19-24} in having a large karyosome, small plasmosome, and delicately basophilic nucleoplasm (Fig. 3a); in some specimens

small clumps of granules occur in the nucleoplasm. The dorsal gland nucleus (g_1) is the largest nucleus of the esophagus, the subventrals (g_{2-3}) being but slightly smaller.

The nuclei of the nerve cells (n_{1-41}) differ from all other nuclei of the esophagus and are similar to one another in that the nucleoplasm contains large basophilic clumps (Fig. 3a) which make them much darker than other nuclei; in general neither karyosome or plasmosome may be observed. The nerve cell nuclei fall into 3 general groups as follows: Small nuclei ($n_{1-10,24,27}$), about 1.15 to 3.3μ long by 1.2 to 2.9μ wide in cross section, with rather coarse basophilic deeply staining material; medium-sized nuclei ($n_{23,25-26,28-38,41}$), about 3 to 5.9μ long by 1.87 to 2.6μ wide in cross section, with fewer basophilic clumps in proportion to the size of the nucleus; large nuclei (n_{39-40}), about 5 to 5.9μ long by 4.3 to 4.5μ wide in cross section. The nuclei of the first type belong to bipolar neurones of the 3 anterior esophageal nerves. The cell bodies of these neurones are extremely narrow. The neurones of the second and third types appear to be commissural nuclei of the postcorpus and bulbar regions. These neurones of the second type have moderate-sized cell bodies (Fig. 3b) and those of the third type have massive cell bodies (Fig. 3b).

ESOPHAGEAL GLANDS

The dorsal esophageal gland opens into the lumen of the esophagus at the anterior end of the precorpus. Its duct and finer structure are similar to those of the dorsal esophageal gland of *Rhabditis* (see Chitwood and Chitwood, 1936). It is difficult to trace the glandular protoplasm in the bulb and particularly to distinguish between it and the sarcoplasm of muscle cells. The large nucleus (g_1) apparently lies within the gland tissue, but it may not; we have attributed the nucleus r_{19} to radial muscle, although there is the possibility that it should be attributed to the dorsal gland, and g_1 to the radial muscle; further study is necessary to determine this point with certainty.

The subventral esophageal glands open into the lumen at the posterior end of the postcorpus near the level of n_{30}. They also are similar to the esophageal glands of *Rhabditis* except that they are situated near the middle of the subventral sectors in the bulbar region and not in the lateral part of these sectors. The same difficulties were encountered regarding the nuclei of the glands as were encountered in the case of the dorsal gland. It is possible that the nuclei r_{20-21} should be attributed to the glands and that g_{2-3} should be attributed to the radial muscles. However, the interpretation which the writers have given to these nuclei seems to be correct.

LITERATURE CITED

CHITWOOD, B. G., and CHITWOOD, M. B. *The histology of nemic esophagi.* Parts I, II. Z. Zellforsch. u. mikroscop. Anat. **22**: 29–37, 38–46. 1934. Part III. This JOURNAL, **24**: 557–562. 1934. Part IV. Ibid. **25**: 230–237. 1935. Part V. Ibid. **26**: 52–59. 1936. Part VI. Ibid. **26**: 331–346. 1936.

ZOOLOGY.—*The systematic position of* Indostomus paradoxus *Prashad and Mukerji, a fresh water fish from Burma.*[1] ROLF L. BOLIN, Hopkins Marine Station of Stanford University. (Communicated by WALDO L. SCHMITT.)

The interrelationships between the sticklebacks, tubemouths, pipefishes, and their relatives have long mystified systematists. The families have been shuffled and reshuffled by Starks,[2] Regan,[3] Jungersen,[4] Gregory,[5] and others into various groups, orders, suborders, and superfamilies in an effort to express their evolutionary history. In spite of careful and painstaking research, the problem still remains unsettled and the natural system obscure. The most doubtful point is the question of whether the Gasterosteoidea (including the families Gasterosteidae and Aulorhynchidae) show affinity to the Scleroparei or to the Hemibranchii and Lophobranchii.

The Indostomidae of Prashad and Mukerji,[6] based upon their new species, *Indostomus paradoxus*, from Indawgyi Lake, Myitkyina District, Upper Burma, is the most recently described family to be allocated to this systematic complex. Although of extreme interest as a possible indicator of the mutual relationships of the other families of the group, it has as yet been discussed only by its authors who state, "This new family is closely allied to the family Solenostomidae and to a certain extent to the Syngnathidae of the order Solenichthys Regan, but differs from either in several important characters."

Through the courtesy of Dr. G. S. Myers of the United States National Museum, I have been able to examine a cotype of *Indostomus paradoxus*. It displays many interesting features and I am convinced that Prashad and Mukerji erred in considering it closely related to the Solenostomidae and Syngnathidae. If we analyze the characters used by these authors to define the family Indostomidae and to differentiate it from its relatives, it appears that the family's affinities are to be sought in more primitive groups than those suggested.

The general body form, although possibly of minor significance, more closely approximates that of the Aulorhynchidae than it does that of any of the other families, certainly far more closely than it approximates that of the Solenostomidae or Syngnathidae. The de-

[1] Received September 5, 1936.

[2] STARKS, E. C. Proc. U. S. Nat. Mus. **25**: 623–625. 1902.

[3] REGAN, C. T. Biologia Centralia Americana: x–xi. 1908.

[4] JUNGERSEN, H. F. E. Kgl. Dankse Vidensk. Selsk. Skrift. (7) Naturv. & Math. **8**: 329–334. 1910.

[5] GREGORY, W. K. Trans. Amer. Philos. Soc., N.S. **23**: 228–229. 1933.

[6] PRASHAD, B. and D. D. MUKERJI, Rec. Indian Mus. **31**: 219–220. 1929.

pressed head and caudal region of the Aulorhynchidae are very suggestive of *Indostomus*, the main proportional differences, though of minor significance, being the slightly greater depression and more robust build of the thoracico-abdominal region of *Indostomus*. It should also be noted that, except for the greater caudal attenuation and the depressed instead of compressed body, *Indostomus* rather closely approximates the hemibranchiate family Aulostomidae.

When the fins are considered, we find the same relationships suggested. *Indostomus* has two dorsal fins, the first one composed of short spines unconnected by membrane, the second having its origin immediately behind the last dorsal spine. This condition is duplicated in the Aulorhynchidae and the Aulostomidae and is far different from the two complete and widely separated dorsals of the Solenostomidae and the single dorsal of the Syngnathidae. The anal fin of *Indostomus* differs from that of the Aulorhynchidae only in lacking a small spine at its anterior end, and from that of the Aulostomidae only in having its rays branched instead of simple. The latter difference also characterizes the second dorsal of these forms.

The pectorals and pelvics of *Indostomus* are similar in size and position to those of the Aulorhynchidae. From the Aulostomidae, *Indostomus* differs in having its pelvics in a more anterior position. This difference appears to be of relatively minor importance when compared to the marked differences existing between the normal pelvics of *Indostomus* and the inordinately enlarged fins of the Solenostomidae or the totally absent fins of the Syngnathidae. Further, the pelvics of *Indostomus* are composed of four rays, not one spine and three rays as stated in the original description, the outer ray being enlarged and unbranched, but jointed. This is the condition found in the Aulostomidae and differs from that found in the Aulorhynchidae as well as the Solenostomidae. The two latter families have a well developed spine in the pelvic fin.

The armature of the body in *Indostomus* is very similar to that of the Syngnathidae and, in all probability, strongly influenced Prashad and Mukerji to consider it a close relative of the pipefishes. It must be remembered, however, that such armature has been developed in many widely separated families. We find it in the Loricariidae, the Ostraciidae, and the Agonidae, and while the importance of the bony scutes should not be minimized, neither should their importance be unduly stressed because of the conspicuous nature of the character. Its significance as an indicator of close relationship in the case under discussion is somewhat diminished by the contradictory evidence of

the body form and is much overshadowed by the evidence of the fins. Finally, the Aulorhynchidae are also equipped with bony scutes, although they are deeply imbedded and restricted to narrow median and lateral bands.

Prashad and Mukerji state that *Indostomus* is without teeth. A careful examination of the cotype reveals moderately broad bands of minute, villiform teeth on the premaxillary and dentaries, another feature in which the species in question is similar to both the Aulorhynchidae and Aulostomidae and one in which it differs from the Solenostomidae and Syngnathidae.

The nostrils of *Indostomus* I find to be single on each side, appearing as an elongated slit. This is clearly shown in Prashad and Mukerji's excellent figures, although they state that there are two nasal openings and indicate in their table that these are similar to the double nostrils of the Syngnathidae. The single opening is somewhat more extensive than that of the Aulorhynchidae and is clearly different from the double openings of the Aulostomidae and Syngnathidae, but is hardly to be compared to the open nasal organ of the Solenostomidae.

The Indostomidae are said to have "four complete lobate gills." The Syngnathidae, however, of all the fish which I have been able to examine, are the only ones in which the gills are so sharply modified in form and structure that they deserve the special designation lobate. The gills of the Solenostomidae, although equipped with comparatively few filaments, represent only one extreme in a very wide but even numerical variation, and do not differ in basic form from the gills of other teleosts. In the number and shape of the filaments *Indostomus* is intermediate between the Aulorhynchidae and the Aulostomidae on the one hand and the Solenostomidae on the other.

The lateral line system of *Indostomus* is much reduced. Small pores in the interorbital space, behind the eye, on the occiput, and just anterior to the upper end of the gill opening indicate that the supraorbital, infraorbital and supratemporal canals are present. This condition is similar to that found in the Centriscidae, and is intermediate between that of the Aulorhynchidae and the Aulostomidae with their well developed lateral line systems and that found in the Solenostomidae and Syngnathidae without any lateral line system at all.

The final analysis of the relationships of *Indostomus* must depend upon osteological investigations. Unfortunately, the species is so small (the only available specimen is 26 mm in standard length) that osteological investigation of such diagnostic characters as the pres-

ence or absence of some of the pterygoid or branchial elements is impossible without macerating. This I have been unable to do, as the cotype which I have examined is apparently the only specimen of the species in this country and is too valuable to destroy.

Of the known osteological characters, the sutural connection of the post-temporal with the cranium is indicative of relationship to the Hemibranchii and Lophobranchii. On the other hand, the fact noted by Prashad and Mukerji that none of the anterior vertebrae are fused indicates that *Indostomus* is not closely related to these groups, but belongs instead with or near the Gasterosteoidea.

The branchiostegals are 5 in number on the cotype, not 6 as recorded in the type description. This number closely approximates that found in the Aulorhynchidae, 4; equals that found in some of the Aulostomidae, 4–5; and is markedly different from the much reduced number found in the Solenostomidae, 1; and also the Syngnathidae, 1–3.

From the available evidence it seems that the Indostomidae can claim no very close relationship to any known family. The only character tending to link it to the Lophobranchii is the nature of the armature. The majority of characters, the body form, fins, teeth, lateral line system, anterior vertebrae and branchiostegals, indicate that its relatives should be sought among the Gasterosteoidea or Hemibranchii. Of the families comprising these two groups, the Aulorhynchidae and Aulostomidae are by far most similar to the Indostomidae. The latter family appears in many respects to occupy an intermediate position and serves as additional evidence of the relationship of the Gasterosteoidea to the Hemibranchii. While this relationship may not be close enough definitely to validate the questionable order Thoracostei, it is much closer than the relationship of the Gasterosteoidea to the Scleroparei which was suggested by Jungersen.

ENTOMOLOGY.—*A redisposition of* Monoxia puncticollis *and allied species.*[1] Doris H. Blake. (Communicated by Austin H. Clark.)

LeConte, in his treatment of *Galeruca* in 1865, divided the genus into five groups, the fifth group consisting of two species, *G. maritima* and *G. morosa*, both described by him. In 1885 he added a third species, *G. erosa*. These three species have been synonymized by Horn with *Monoxia puncticollis* (Say). LeConte had never been able to

[1] Received May 22, 1936.

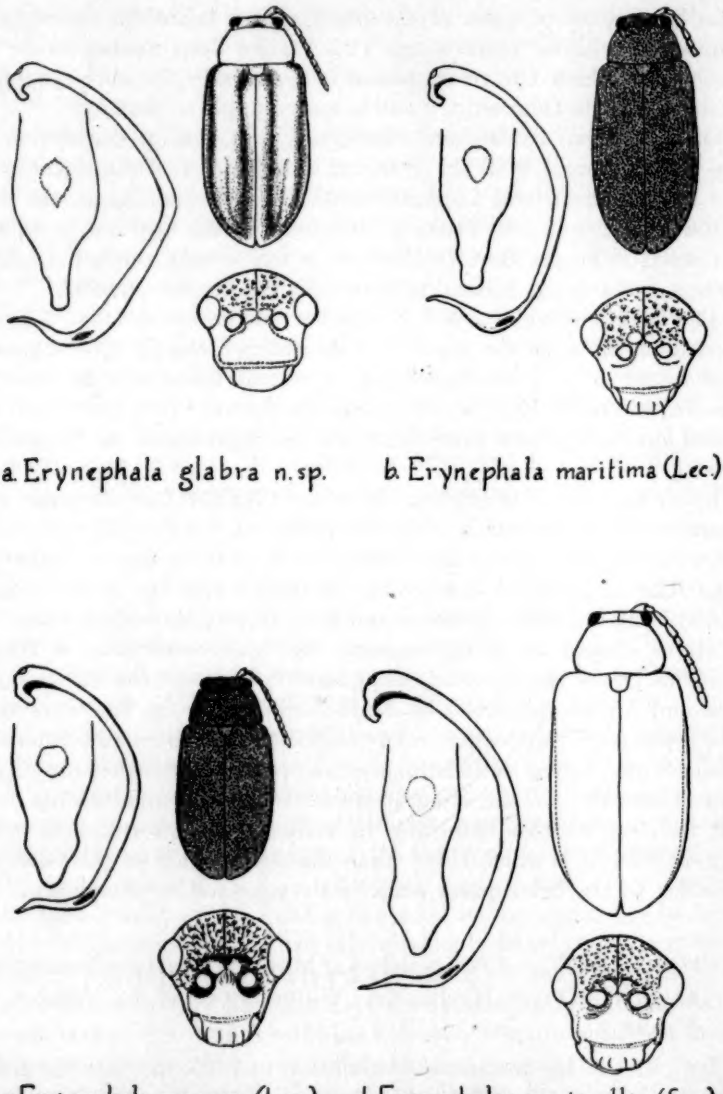


Fig. 1.—a. *Erynephala glabra* Blake, type, Sierra de Durango, Mexico. b. *Erynephala maritima* (Lec.), type in LeConte collection; Gulf States. Genitalia from specimen from Wollaston, Mass. c. *Erynephala morosa* (Lec.), type in LeConte collection; San Francisco, Calif. Genitalia from specimen from Alameda, Calif. d. *Erynephala puncticollis* (Say), type of *G. erosa* Lec. in LeConte collection. Genitalia from specimen from Salt Lake, Utah.—Habit, about 5×; front of head, about 10×; genitalia in dorsal and lateral view, much enlarged.

determine what species Say had before him in describing *G. puncticollis*, and at one time "was disposed to think" it might be related to *Monoxia debilis*. Horn used more than a page in attempting to show that the three species described by LeConte are in reality all forms of Say's species *G. puncticollis*. The fact that these species are all twice as large as Say's measurements of *puncticollis* he dismissed as a slip of the pen on Say's part. Even if this measurement was an error by Say, there is still some objection to placing these very unlike species in LeConte's homogeneous group of *Monoxia*, and still more to reducing to one species three that have very definite and distinctive characters.

These three species agree with the majority of the species of *Monoxia* in one respect,—the claws of the male are toothed and of the female simple. Otherwise the two groups are not closely related, and I agree with Dr. Böving,[2] who found their larval characters entirely different from those of the smaller species of *Monoxia* and with LeConte, who never did incorporate them in that genus, that they should not be put with *Monoxia*. Although Dr. Böving does not find much difference between the larva of *puncticollis* and that of *Galerucella notata*, the mature beetles do not bear any close resemblance to species of the latter genus. Therefore it has seemed best to set this homogeneous group aside in a separate genus.

Erynephala, new genus

The genus *Erynephala* is separated from *Monoxia* (1) by its longer and differently shaped head, (2) by its differently shaped prothorax, which is widest near the base and is not obliquely truncate at the basal angle, and the disc of which is not channelled in the middle or depressed on the sides as in *Monoxia;* (3) by its pygidium, which is not deflexed, as is usually the case in the male of *Monoxia;* (4) by its much longer and differently shaped aedeagus; (5) by its different larval habits (the larvae of *Monoxia* are leaf miners, and the larvae of *Erynephala* feed in the open); (6) by its different larval characters, as shown by A. G. Böving.

The genus *Erynephala* is separated from *Galerucella* (1) by its shorter antennae; (2) by its differently shaped prothorax; (3) by its claws, which are simple in the female and toothed in the male; (4) by its longer and quite differently shaped aedeagus.

Erynephala includes four closely related species, three of which occur in the United States, and one which is known only from the Sierra de Durango in western Mexico. Although *E. puncticollis* (Say) was the first to be described, *E. maritima* is designated as the type of the genus because of the somewhat doubtful application of Say's name. Of the United States species, *maritima* is known to occur from Halifax, N.S. to Texas, and there is one species labeled Jamaica in the Bowditch collection at Cambridge. The second species, *puncticollis*, is known from Texas (inland) to Manitoba in

[2] Böving, A. G., Proc. U.S.N.M., 75: 29. 1929.

the Great Plains and Rocky Mountains, and has also been collected in the Federal District near Mexico City, Mexico. The third species, *morosa*, is known only from the California coast. The three United States species are feeders on Chenopodiaceae and inhabit alkaline or saltmarsh regions. In the western United States they are called "alkali bugs."

They are all considerably larger than the species of *Monoxia*, ranging from 6 to 9 mm. All are dull brownish in color, sometimes piceous, and sometimes the elytra are marked by two rather indefinite vittae, one lateral and the other subsutural. The head is densely punctate and more or less pubescent above, with the median line not always well defined. The lower front is not produced, but broad, flat, and glabrous. The antennae are not half as long as the body, with the third joint longer than the fourth, the fourth longer than the fifth, and the remainder approximately the same length, and longer than broad. The prothorax is not twice as wide as long, and the sides are only slightly rounded, not at all angulate, and are narrowed anteriorly. The basal angles are not prominent and are without nodules. The disc is somewhat uneven, with a small depression in the middle and one on either side, not nearly as marked as in *Galerucella* or *Monoxia*, and the surface is more or less coarsely punctate and nearly glabrous. The elytra are elongate, with parallel sides, slightly convex, without depressions, densely punctate, and either glabrous or only moderately covered with short pubescence. The epipleura are visible nearly to the apex. The anterior coxal cavities are open. The tibiae are not sulcate, and the first tarsal joint is as long as the next two. The claw in the male has a fine tooth on the inner side, not as long as the outer, and in the female the claw is untoothed. The aedeagus is very long, slender, and flat, and because of its length lies in a somewhat bent position in the abdomen. It is quite unlike any aedeagus that I have seen in species of *Galerucella* or *Monoxia*.

KEY TO THE SPECIES OF ERYNEPHALA

1. Upper surface nearly glabrous. Mountains of Western Mexico..... .....*glabra* n. sp.
   Upper surface more or less conspicuously pubescent.....2
2. Elytra markedly wider than prothorax and covered with short, fine pubescence somewhat obscuring the punctation; prothorax usually somewhat depressed with deep coarse punctures. Inland species (Federal District, Mexico; Texas; Great Plains; Rocky Mountains to Manitoba) .....*puncticollis* (Say)
   Elytra not much wider than prothorax; pubescence only moderately dense with punctation not at all obscured; prothorax not depressed and more shallowly punctate. Maritime species.....3
3. Pubescence on head and elytra distinct and rather long; frontal tubercles on head well marked. Pacific coast.....*morosa* (Lec.)
   Pubescence on head and elytra short, not at all conspicuous; frontal tubercles on head indistinctly marked. Atlantic coast...*maritima* (Lec.)

ERYNEPHALA PUNCTICOLLIS (Say)

Galeruca puncticollis Say, Journ. Acad. Nat. Sci. Phila., **3**: 458. 1824.
Galeruca erosa LeConte, Trans. Am. Ent. Soc., **13**: 28. 1885.
Monoxia puncticollis Horn, Trans. Am. Ent. Soc., **20**: 83. 1893, in part.

As already stated, Horn included under Say's name *puncticollis* LeConte's three species, *G. maritima*, *morosa* and *erosa*. It is by no means certain that Say made a mistake in describing *puncticollis* as three-twentieths of an inch long, or that he did not have in hand a beetle quite different from any of LeConte's species and about half their size. However, since no other species appears to answer his description, I am unwilling to change the name of this well known and economically important beetle. Of the three species described by LeConte, Say's name can be applied only to the inland species, *G. erosa*, since Say wrote that *puncticollis* was taken on the Mississippi and on the Arkansas near the mountains.

LeConte described *G. erosa* as "dull yellow, finely pubescent. Head strongly, densely punctured, prothorax cribrate. Elytra finely, very densely punctured, outer joints of antennae and the tarsi fuscous. Length 8 mm. Utah. Quite different from our other species (*maritima* and *morosa*) by the coarsely sculptured thorax which has also four shallow discoidal impressions. The third joint of the antennae is a little longer than the fourth, whereby it differs from Trirhabda, which it greatly resembles in form."

In the LeConte collection are three specimens, all labelled Utah. The one bearing the label *G. erosa* is a female and the other two are males. These correspond with LeConte's description and are without doubt the specimens he had before him in describing the species. The head is pale, with short appressed yellow pubescence, not entirely obscuring the punctation below; the lower front is broad, smooth and shining, and is without the wide depression below the antennal base found in *morosa*. The first four basal joints of the antennae are pale and the rest darker brown. The prothorax is narrowed anteriorly and greatly depressed, with large, coarse punctures, each puncture bearing a short, pale yellow hair. The elytra are wider in proportion to the prothorax than in either *morosa* or *maritima*, and covered with a fine, dense, yellow pubescence, and the punctation is not as coarse as in *morosa*. The body beneath is pale.

This is the most distinctive of the three United States species of *Erynephala*. It is the largest (sometimes as much as 9 mm.), has the densest elytral pubescence, and the most coarsely punctate and depressed prothorax. The aedeagus, resembling that of *morosa* in its tip, differs from both *morosa* and *maritima* in having the opening on the dorsal side situated farther from the tip. As in the other two northern species, there is great variation in color, specimens varying from pale to piceous. Usually the lower front of the head, prothorax and margin of the elytra are pale in the darkest specimens. The elytra in the majority of the specimens examined are yellowish brown, but occasionally they are vittate.

Distribution: Texas (Del Rio, El Paso, Barstow, New Castle, Pecos), Kansas (Meade Co., Clark Co., Wichita), Nebraska (Lincoln), New Mexico (Hagerman, Albuquerque, Artesia, Maxwell), Utah (Provo, Bear River, Thatcher, Garfield, Saltair, Salt Lake), Colorado (Colorado Springs, Rocky Ford, Ft. Collins, Longmont, Greeley), Idaho (Sugar City), Montana (Billings), Manitoba (Winnipeg, Stonewall, Baldwin).

Erynephala morosa (LeConte)

Galeruca morosa LeConte, Rept. Pacific Survey, p. 70, 1857.
Monoxia puncticollis Horn, Trans. Am. Ent. Soc., **20**: 83. 1893, in part.

LeConte's Latin description of *G. morosa* may be translated thus: elongate, piceous, lightly covered with cinereous pubescence, the head finely

and densely punctate, with two smooth callosities over the antennal bases, the prothorax strongly punctate, uneven, with a deep median and two more indefinite lateral foveae; the elytra a little wider than the prothorax, convex, densely and not finely punctate, the suture elevated, flat towards the scutellum; length .25 inch. The description is founded on a single specimen collected in a salt marsh at San Francisco. LeConte states that it resembles a black individual of *G. maritima*, but differs from the eastern species by having the prothorax less flattened in front and less rounded at the sides, and the hind angles not flattened, the elytra more coarsely punctured, and the pubescence longer and nearly white.

In the LeConte collection is the specimen from which LeConte drew up his description, bearing the label *G. morosa* and also *San Fr.* and a round gilt label. It is a male and entirely dark except for the reddish brown mouthparts. The head is without a deep median impression and has two well marked frontal tubercles over the antennal bases. There is also a pronounced depression directly below the antennal base, such as does not occur in either *maritima* or *puncticollis*. The head above is densely, shallowly and coarsely punctate with long white pubescence, longer than in *maritima*. The antennae are entirely dark. The prothorax has nearly straight sides, is slightly convex with a small median depression and two lateral ones, and is shiny and covered with coarse, shallow, sometimes confluent punctures, not so dense in the middle. There is a slight inconspicuous pubescence on the sides. The elytral humeri, as in *maritima*, are not prominent, and the depression within is very slight. The elytra, not much wider than the prothorax, are shiny and have dense, coarse punctation and a white and not very conspicuous but long pubescence, slightly longer and more erect than in *maritima*.

LeConte points out plainly the differences between *morosa* and *maritima*. His statement that the hind angles of the prothorax of *morosa* are less flattened than in *maritima* does not hold in all cases, but generally the prothorax of *morosa* is not so depressed as that of *puncticollis*. *Morosa* differs from both *maritima* and *puncticollis* by the deep depression below the antennal bases on the lower front, as well as by the differently shaped aedeagus. It differs from *puncticollis* by its smaller size, less deeply punctate and depressed prothorax, less pronounced humeri, with the elytra not as wide in proportion to the prothorax as in *puncticollis* and longer white pubescence, in contrast with the short, yellowish pubescence of *puncticollis*. Like both *maritima* and *puncticollis*, *morosa* has several color forms. It may be pale, or the elytra may be vittate.

A. T. McClay writes that he has always collected this species in the salt marshes along the California coast.

Distribution: California (Lake Merritt, Alameda Co.; Millbrae, Los Angeles Co., Oakland, San Diego, Seal Beach).

ERYNEPHALA MARITIMA (LeConte)

Galeruca maritima LeConte, Proc. Ac. Nat. Sci. Phila., **17**: 218. 1865.
Monoxia puncticollis Horn, Trans. Am. Ent. Soc., **20**: 83. 1893, in part.

LeConte's Latin description of *G. maritima* may be translated thus: elongate, testaceous, fuscous or black; head coarsely punctate, prothorax short, narrowed anteriorly, with broadly rounded sides and not at all prominent angles, at base on either side obliquely subtruncate; the disc somewhat convex, strongly punctate, shortly canaliculate, and on either side vaguely foveate; the posterior angles flattened and obtuse; the elytra densely

and rather finely punctate and covered with short, not dense, pale pubescence. Length .30 inch. There are color varieties in which the prothorax is partly testaceous and the elytra black with the margin and suture pale. No type locality is given, but LeConte states that the species is abundant on the seacoast from New York to Florida.

In the LeConte collection the specimen bearing the label *G. maritima* has also a round bright red label indicating the locality as the Gulf states. It is a mutilated male specimen without eyes, with only a portion of one antenna, and lacking two legs and part of a third. Except for the yellowish brown labrum it is entirely dark. The head is not at all conspicuously pubescent, in contrast with the long white pubescence of *morosa*, and is coarsely and confluently but shallowly punctate, not as densely punctate as in *morosa* and *puncticollis*. The antenna, of which only the first six joints remain, is dark. The prothorax is not depressed except for a faint median anterior spot and two faint lateral impressions and flattened hind angles, and has only slightly arcuate sides. It is shining and with scattered coarse and rugose punctation, but is not as densely punctate as in *morosa* nor excavated with deep coarse punctures as in *puncticollis*, and is nearly smooth in the middle. There is little trace of pubescence. The elytral humeri are not prominent, as they are in *puncticollis*, and there is only a slight trace of intrahumeral depression. The punctation is dense, coarse and distinct, but not as coarse as in *morosa*, and there is rather sparse short pubescence, in contrast to the long pubescence of *morosa* and the thick, fine pubescence of *puncticollis*. Besides this specimen, there are eight others, four males and four females, labeled "Del." All are somewhat paler, some yellow brown without vittae, others with entirely dark elytra and particolored prothorax, others vittate.

This species is distinguished from *morosa* by the less conspicuous and shorter pubescence, the more finely punctate elytra, the distinctly flattened hind angles of the prothorax (see notes on *morosa*), and the quite differently shaped tip of the aedeagus. It is distinguished from *puncticollis* by its generally smaller size, less coarsely and deeply punctate and less depressed prothorax, less prominent elytral humeri, more sparsely pubescent elytra, and the differently shaped tip of the aedeagus.

Some specimens from Florida and Texas, possibly representing *M. puncticollis* var. *texana* Schaeffer[3] are usually pale with brown elytral vittae, and show a more pronounced swelling near the tip of the aedeagus than is found in the northern specimens. Often in the northern specimens there is a one-sided swelling near the tip, so that this variation in the southern specimens seems to be only a matter of degree. The beetles do not present any other structural differences.

E. maritima is not known to be injurious to beets. It is found only in the salt marshes on the eastern coast feeding on *Salicornia*, *Dondia*, and *Salsola*, although in breeding cages I have reared it with no difficulty from egg to adult on beet leaves.

Distribution: Nova Scotia (Halifax), Maine, New Hampshire (Rye Beach), Massachusetts (Ipswich, Marblehead, Wollaston, North Cohasset, Cambridge), Connecticut (Milford, Lyme), New York (Long Island, New York City, Coney Island), New Jersey (Boonton, Avalon, Longport), Maryland (Ocean City), Virginia (Ft. Monroe, Virginia Beach, Wacha-

[3] Schaeffer, Can. Ent., 64 (10): 237. 1932. According to Schaeffer this variety is more closely related to *maritima* than to *morosa* or to "typical *puncticollis*." It would appear that he regards LeConte's species *morosa* and *maritima*, which he calls "forms," equal in rank with his variety *texana*.

preague), South Carolina (Charleston), Georgia, Florida (Sand Point), Louisiana (Cameron), Texas (Corpus Christi, Brownsville, Galveston), Jamaica (Kingston, Liguana Plain). Two specimens labeled *Kansas* are probably mislabeled.

Erynephala glabra, n. sp.

In size, shape and coloring similar to *E. maritima*, but nearly glabrous on upper surface. Head reddish brown deepening to darker brown on occiput, coarsely and confluently punctate on upper half with a slight trace of fine pubescence. Tubercles not pronounced and depression below antennal base not marked. Antennae reddish brown and like the other species. Prothorax not twice as wide as long, narrowed anteriorly and with slightly arcuate sides; disc with trace of central and two lateral depressions, hind angles not as distinctly flattened as in *erosa* or *maritima;* punctation coarse and scattered, slightly more distinct than in *maritima;* only a slight trace of pubescence visible under high magnification; color deep reddish brown. Scutellum pubescent. Elytra with humeri no more developed than in *maritima* and *morosa*, densely and coarsely punctate, nearly glabrous excepting a slight trace of pubescence near lateral margin which disappears at apical angle; reddish brown with two darker vittae, one near suture, the other lateral, these broadening and coalescing at apex. Body beneath dark brown deepening to piceous on metasternum and first abdominal segments, lightly pubescent. Length 6.5 mm; width 3 mm.

Type: male in Bowditch collection, Museum of Comparative Zoology, Cambridge, Mass.

Type locality: Sierra de Durango, Mexico.

Remarks: This species from the mountains of western Mexico is very similar to the eastern maritime species. The only external differences between the two are the slightly deeper punctation and the nearly glabrous upper surface of the Mexican species. All the other species of the genus have distinctly pubescent elytra. The aedeagus, too, is different, having a tip similar to the eastern species, but being much wider behind the tip.

ENTOMOLOGY.—*Some new leafhoppers related to* Thamnotettix.[1]

E. D. Ball, University of Arizona, Tucson, Arizona.

The writer is working on the tree and shrub inhabiting division of the old genus *Thamnotettix* and has recently divided the group into a number of genera. As there are requests for determinations in some of these divisions the following species are described.

Gloridonus spatulatus Ball n. sp.

Resembling *gloriosus*, smaller, golden with less green on the clavus. The female segment with a narrower and shorter notch. Length ♀ 5.5. mm.

Vertex shorter and more obtusely angled than in *gloriosus*, scarcely half longer on middle than against eye, female segment long, rounding posteriorly with a slightly wedge shaped notch reaching one third of the way to the black marked base. Male plates longer and roundingly narrowing, almost oval instead of very broad and almost truncate as in *gloriosus*. The finger like tips curved up around the tips of the smaller and shorter styles.

[1] Received July 11, 1936.

Pygofers longer than the plates with their apices extending as white spatulate tips. These tips much exceeded by a pair of long black spines that lay alongside the anal tube. In *gloriosus* the pygofers are much shorter and blunter and do not equal the plates while the spines are short and curved.

Holotype[2] ♀ and three paratypes Riverside, California, June 10, 1908, allotype ♂ and five paratypes Ontario, California, June 12, 1908, all collected by the writer, and six paratypes Mint Canyon, California, June 7, 1935, taken by P. W. Oman and returned to him.

Allygianus clathratus Ball n. sp.

The male resembling a small and slender *gutturosus*, the female a large golden *limbatus* Van D., both sexes heavily reticulate. Length ♀ 7 mm.; ♂ 5.5 mm.

Vertex resembling that in *limbatus*, only slightly more than a right angle, almost as long as its basal width instead of very obtuse and nearly twice wider than long as in *gutturosus*. Elytra very long, parallel margined, not appressed, venation even more heavily reticulate than in *gutturosus*, several cross nervures between the sectors and the central anteapical, constricted and several times divided. The female uniform pale cinnamon, almost golden, the male smoky brown with definite arcs on front and a broken crescent above. A pair of dashes anteriorly and a pair of dots on the median line of vertex, four spots on disc, a broken line on pronotum. The nervures in both sexes broadly white.

Holotype ♂ allotype ♀ and seven paratypes Pine Valley, July 6, 1931, and two Beaumont Aug. 1, 1912. All taken by the writer in southern California.

Pasadenus chicanus Ball n. sp.

Resembling *pasadenus* Ball, bigger, broader, with widely flaring elytra and semi-circular male plates. Length ♀ 7 mm.

Vertex wider than in *pasadenus* but equally pointed and elytra longer, broader, with shorter apical cells. Color similar, the ivory saddle broader, the disc of the pronotum light brown with the anterior margin bearing an irregular row of black dots interrupted in the middle with yellow. Female segment with a quadrangular notch twice as wide as in depth, bordered by a black line while in *pasadenus* the notch only half as wide and is set off by a black area to the base. Male plates short, together semicircular with recurved finger like tips, pygofer hooks large turned down with the curved tips almost touching the plates. In *pasadenus* the male plates are twice as long, narrowing to almost truncate tips while the pygofer spines are long, slender, curved outward and upward, and extend well beyond the plates.

Holotype ♀ allotype ♂ Chico, California, Aug. 11, 1912, and one paratype male, Big Bar, California, July 24, 1912, all taken by the writer, 4 paratypes Redding, California, June 28, 1935, and eight Paynes Creek, California, June 27, 1935, all taken by P. W. Oman and returned to him.

Pasadenus margaritae Ball n. sp.

Resembling *pasadenus* but much paler, the brown band reduced. Male plates long, spatulate. Length ♀ 5.5 mm.

Structure of *pasadenus* nearly, more reticulations on the posterior half of corium. Vertex and face creamy shading to straw color below. Pronotum pale brown, subhyaline, the anterior submargin with irregular brown dots

[2] Types in the author's collection unless otherwise indicated.

broken on the median line. Elytra with the ivory saddle of *pasadenus* very faintly margined with brown, a definite apical band. Female segment scarcely emarginate but with a broad black median stripe. Male plates long spatulate, three times the length of the valve, their apices turned up into chitinized hooks. Pygofer hooks just visible at the sides of the plates at about two thirds their length.

Holotype ♂ allotype ♀ and three male paratypes, Alpine, July 5, 1931, one female Pasadena, July 31, 1912, and one female Santa Margarita, August 6, 1921. All taken in California by the writer.

Doleranus atascasus Ball n. sp.

Resembling *perspicillatus* O. & B. but much longer and narrower. The head markings even more definite while the long elytra have only traces of the dark markings. Length ♀ 4 mm.

Vertex, pronotum and scutellum as in *perspicillatus* nearly with the dark markings in front and the brown ocellate spots very definite. Face longer and narrower with arcs on clypeus and dark lines around lorae. Elytra much longer and narrower, one half longer than abdomen, the anteapical and apical cells long, the central anteapical but little inflated posteriorly. The nervures on clavus milky, those on corium except the outer sector smoky widened on the cross nervures but with only faint markings in the cells. Female pygofers longer and narrower; the segment rounding and elevated posteriorly with a slightly bifid projection more than twice as long as in *perspicillatus*. The male plates with long narrow fingerlike projections stronger than in that species.

Holotype ♀ Atascasa Mts., Nov. 3, 1935, Allotype ♂ Santa Rita Mts., Apr. 5, 1931, and one female paratype Huachuca Mts., Oct. 13, 1931. All taken by the writer in the mountains of Arizona.

Doleranus kinonanus Ball n. sp.

Resembling *longulus* in form and color, shorter with a shorter head and rounding male plates. Pale cinnamon with smoky clouds behind the cross nervures. Length ♀ 4.5 mm.

Vertex obtusely conical, length less than two-thirds the width at base, shorter than in *longulus*. Pale cinnamon above and below, traces of brown arcs on the sides of the clypeus, faint indications of usual color pattern on dorsum and definite smoky clouds margining the cross nervures. Female segment but little over one half as long as in *longulus* with the posterior margin slightly angularly excavated with a definite slightly dark margined triangular projection. Male valve and plates apparently fused into a convex shield as broad as long, the tips of plates distinct and separated by a "V" shaped notch.

Holotype ♀ allotype ♂ and 16 paratypes taken by the author at Kino Bay, Sonora, Mexico, Dec. 9, 1931.

Ollarianus rubianus Ball n. sp.

Large, size of and superficial resemblance to *T. languidus* Ball, pale creamy with four black spots on vertex; elytra smoky inside of broad white, almost parallel, margins. Length ♀ 6 mm.

Vertex very short, much shorter than in *balli*, over two and one-half times wider than long, almost parallel margined, pale, with two large black spots above the ocelli and two smaller ones between, sometimes elongate; pronotum two and one-half times as long as the vertex, pale with indefinite sub-

marginal spots and obscure smoky stripes. Elytra, long flaring subhyaline, the nervures and apices smoky, the dark tergum and under wings showing through give the insect a smoky appearance with the broad flaring white costal margin in sharp contrast. Below creamy with a smoky crescent under the vertex and a few brown arcs well down on clypeus. Female segment twice as wide as long, posterior margin truncate with the angles rounding (arched so as to appear excavated), with a broad triangularly rounding median projection, male valve obtusely triangular, plates together long triangular three times the length of vale, the margins concave to the broad finger-like apices which almost equal the pygofers.

Holotype ♀ allotype ♂ and four paratypes Nov. 3, 1935, two paratypes Apr. 17, two May 15, and one May 23, 1936, all taken from the slopes of Mt. Atascasa, Arizona, by the writer.

Ollarianus bullatus Ball n. sp.

Size and form of *balli* nearly. Pale creamy, with the inner pair of spots on vertex the largest, instead of those above the ocelli as in that species, and the face of the male black. Length ♀ 4 mm.

Vertex about twice as long as wide, almost parallel margined, over two-thirds the length of the pronotum. Elytra as in *balli*, inclined to be flaring with similar venation. Female segment twice wider than long, parallel margined but elevated so as to appear slightly angularly excavated, a broad roundingly triangular median projection. Male valve very broad and short, the plates together broad, roundingly narrowing with long filamentous projections which are sometimes orange as in *strictus* Ball. Pale creamy with a slight smoky cast to the elytra, a pair of small spots above the ocelli, a large pair between these some distance back from the margin, a pair just behind the eyes, a pair on the disc of the scutellum and another pair on the margins before the apex. Any or all of these spots may be missing but the face of the male has a black or smoky cloud in all examples.

Holotype ♂ allotype ♀ and three paratypes Aug. 6, 1934, one Aug. 5, 1934, one June 8 and one June 23, 1929, all taken by the writer in the Baboquivari Mts., Arizona except the last two which were taken in the desert nearer Tucson, Arizona.

Ollarianus ollus Ball n. sp.

Form of *strictus* nearly, larger, longer and more slender than *bullatus*, with a short uniformly rounding vertex and faint markings, no black on face. Length ♀ 4.6 mm.

Vertex slightly narrower than in *bullatus* parallel margined with four fine points or none, no dark on face. Markings on pronotum and scutellum small or wanting. Elytra long and inclined to be flaring. Slightly smoky in the males with the cross nervures emphasized. Female segment more than half as long as its basal width, roundingly narrowing, the posterior margin nearly truncate with the median third roundingly produced. Male valve small triangular, plates broad, long spoon-shaped with the tips elongated equalling the pygofers, the concave portion of the margins before the tips heavily black marked.

Holotype ♂ allotype ♀ and 4 paratypes together with two nymphs taken by the writer from the east slope of the Santa Rita Mts., Arizona, Aug. 18, 1935.

Ollarianus rudiculus Ball n. sp.

Size and form of *ollus* nearly, the elytra long but not as inclined to be flaring. Pale smoky, heavily marked. Length of ♀ 5 mm.

Vertex short parallel margined, creamy with four black spots in a reversed crescent. Pronotum smoky or cinereus with a submarginal row of spots, the pair behind the eyes usually round and definite. Scutellum creamy with a smoky pattern, a pair of round black spots on disc and another pair before the apex, elytra smoky subhyaline, the nervures pale brown. Face and below pale, in dark examples a pair of dashes on the upper part of the clypeus, another pair at apex and irregular fine dots outline the arcs. The female segment, as in *ollus*, the male valve short and broad, triangularly narrowing and then produced into short, broad, divergent apices longer than the pygofers.

Holotype ♂ and allotype ♀ and one paratype taken in Bear Canyon (Labeled Tucson) March 22, 1931. Three paratypes Sabino Canyon, eight from Atascasa Mt. and two Nogales, all taken by the writer in the mountains of Arizona.